INSTRUCTION BOOK FOR BRISTOL INSTRUMENTS

INSTRUCTION BOOK NO. T500F ISSUE NO. 1

INSTALLATION, OPERATION AND SERVICE

OF BRISTOL'S SERIES 500 AND 534

ELECTRONIC FREE-VANE TEMPERATURE CONTROLLER

FOR SERIAL NO. 645975

RECORDING
INDICATING
CONTROLLING
TELEMETERING

INSTRUMENTS

BRISTOL'S

THE BRISTOL CO. WATERBURY 20, CONN.

PLACE THESE INSTRUCTIONS WITH THE MAN IN CHARGE OF YOUR INSTRUMENTS

I M P O R T A N T

1. Read these instructions NOW before installing instrument.
2. Keep these instructions permanently & accessibly filed for future reference.
3. Be sure to specify MODEL & SERIAL numbers when ordering parts, instructions, diagrams or data.
4. Ship instruments or parts for repair or exchange only to Bristol's main or branch factories—not to Sales Offices.
5. Be sure to—
   1. Identify your shipments with your exact return address & order number.
   2. Write nearest Bristol Factory or office giving your order number, directions & address for return shipment, full instructions for repair, etc.
6. Report damage to shipments at once to shipping company. The *customer assumes responsibility for collecting any claim for damages* from the shipping company, on all shipments made on a collect basis.

WHO WILL SERVICE YOUR BRISTOL INSTRUMENT?

Divided responsibility produces misunderstanding and inattention. We therefore urge that all Bristol instruments in your plant be assigned to the care of one responsible man. He will rapidly become so familiar with routine chart changing, inking, checking and adjusting necessary to keep instruments in good working order, as to require only a few minutes time per day. Bristol will be pleased to supply additional information or personal instruction to instrument service men.

INSTRUCTION BOOK NO. T500F ISSUE NO. 1

INSTALLATION, OPERATION AND SERVICE

OF BRISTOL'S SERIES 500 AND 534

ELECTRONIC FREE-VANE TEMPERATURE CONTROLLER

FOR SERIAL NO. 645975

INDEX PAGE

THIS BOOK CONTAINS THE FOLLOWING INSTRUCTIONS IN THE FOLLOWING ORDER

ORDER IN BOOK	TITLE	NUMBER
1	Electronic Free-vane Control Instructions	B2030
2	Wiring Diagrams	B2032
3	Thermometer-system Installation and Service	T8000A
4	Case Unpacking and Installation	Y19800
5	Recording-system Installation and Service	Y19802
6	Parts List for Electronic Control	B2035
7	Parts List for Convertible Bulb	T8005
8	Parts List for Case and Recording Accessories	Y19807
9	Thermometer Case Connections and Color Code	Sh-011037
10	Mounting Dimensions	Y19809
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
LAST	ADDRESS & PHONE NUMBERS BRISTOL'S BRANCH FACTORIES & OFFICES	W18220
	PLUS FOLLOWING SPECIAL INSTRUCTIONS AS REQUIRED	
27	WIRING DIAGRAM - WET & DRY BULB THERMOMETER CONTROLLER	RC-94
28	WET & DRY BULB RECORDING PSYCHROMETER INSTRUCTIONS	H10010
29	RELATIVE HUMIDITY TABLE	H10004
30	TIME PROGRAM CONTROLLER INSTRUCTIONS	W18202
31	METHOD FOR CUTTING CAMS FOR TIME PROGRAMS	Y19174

TO NO.

TO NO.

EFFECTIVE

Instruction No. B2030
Issued June 1954

INSTRUCTION NO. B2030

(Issue No. 2 of 6/54)

INSTALLATION, OPERATION AND SERVICE OF BRISTOL'S SERIES 500 AND 534 ELECTRONIC FREE-VANE CONTROLLER

TABLE OF CONTENTS

	Page
PART I GENERAL	3
A. Description	3
B. Types of Control	3
C. How the Electronic Control Unit Works	4
D. How the Proportional-input Unit Works	4
PART II INSTALLATION	5
A. Unpacking and Mounting	5
B. Measuring System	5
C. Wiring	5
PART III OPERATION	5
A. How to Start Controllers	5
B. How to Start Controllers with Proportional-input Control	5
C. Checking and Adjusting the Control Point	7
D. Checking and Adjusting the Differential Gap	7
PART IV SERVICE	7
A. Checking the Tubes	7
B. Replacing a Control Unit	7
C. Servicing of Relay Contacts	7
D. How to Install Change Gears on Proportional-input Units	8
E. Repairs, Correspondence and Shipping	8

THE BRISTOL COMPANY WATERBURY 20, CONN.

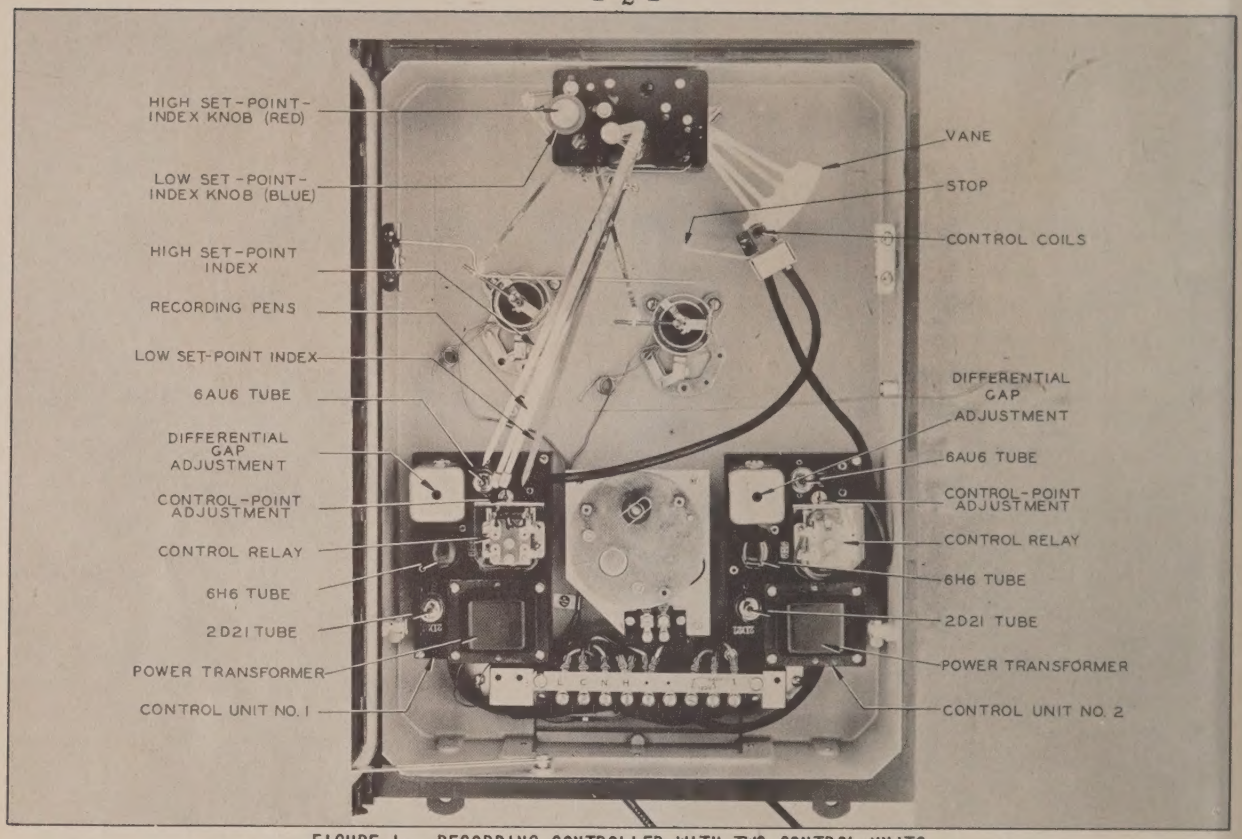


FIGURE 1. RECORDING CONTROLLER WITH TWO CONTROL UNITS

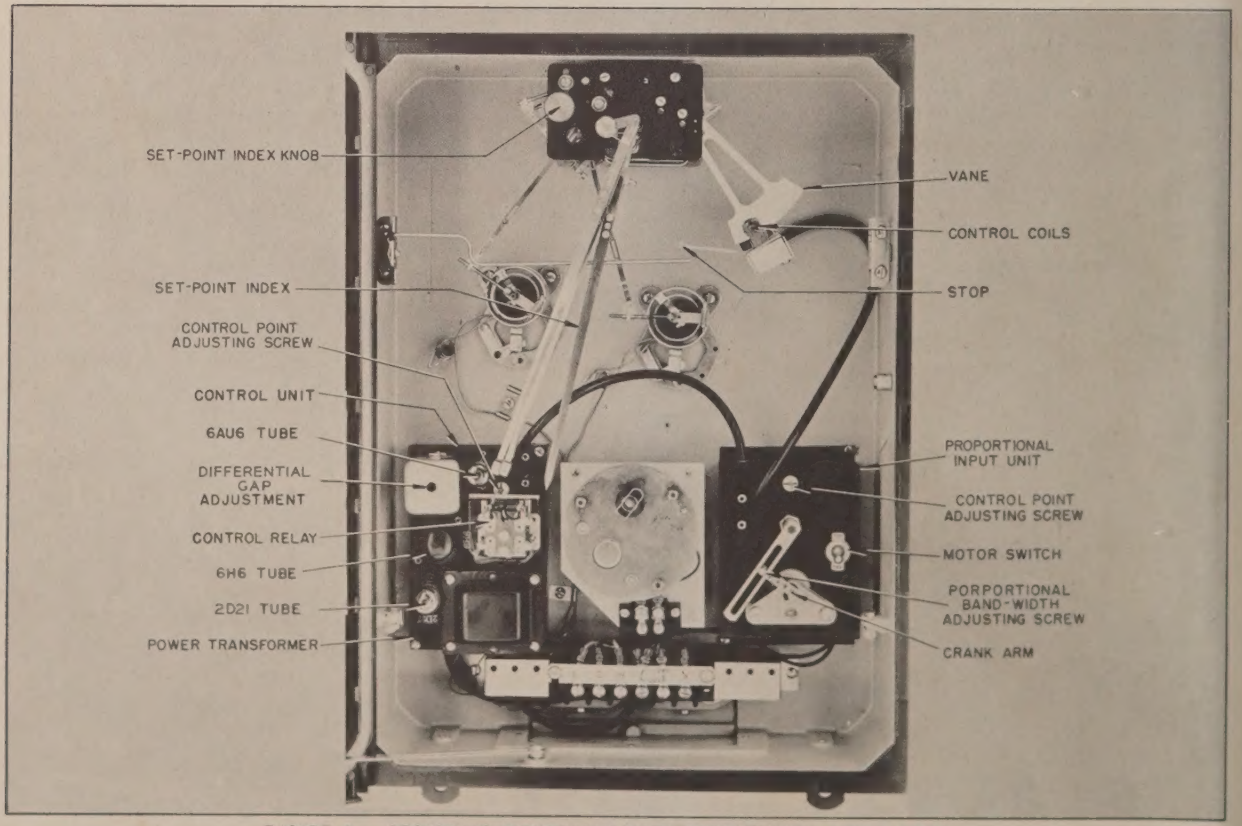


FIGURE 2. RECORDING CONTROLLER WITH PROPORTIONAL INPUT UNIT

Note: This instruction covers only the Electronic Free-vane Control System. See separate instructions covering the measuring system, recording system, etc., which are furnished as required.

PART I GENERAL

A. Description

The Bristol Electronic Free-vane Controller consists of a measuring system (temperature, pressure, flow, etc.) with the necessary indicating or recording components and one or two electronic control units as required.

Controllers with one control unit provide L, H or LH type control and are equipped with one set-point index. Instruments with one control unit may also be equipped with a proportional-input unit.

Controllers with two control units provide LOH or LNH type control and are equipped with two set-point indexes. Two-pen controllers with two control units are sometimes wired to provide an LH type control for each pen. Separate wiring diagrams are furnished to cover these applications.

The electronic units may also be used to operate alarm circuits in instruments such as Bristol's Metameter Receivers.

The electronic control unit and the proportional-input unit are especially adapted for easy installation, interchangeability and simplified service.

B. Types of Control

The Series 500 Electronic Controllers can be furnished with any one of seven standard types of control: L, H, LH, LOH or LNH, and L or H with proportional-input control. Special control circuits are also available on order.

1. L Control. When the measured variable is lower than the set-point index, a **low** control load is energized to raise the measured variable back to the set point. When the measured variable goes above the set-point index, the "L" load is deenergized.

2. H Control. When the measured variable is higher than the set-point index, a **high** control load is energized to lower the measured variable. When the measured variable is lower than the set-point index, the "H" load is deenergized.

3. LH Control. When the measured variable is lower than the set-point index, a **low** control load is energized to raise the measured variable. When the measured variable is higher than the set-point index, a **high** control load is energized to lower the measured variable.

4. LOH Control. When the measured variable is lower than the low set-point index, a **low** control load is energized to raise the measured variable. When the measured variable is between the low and high set-point indexes, both high and low loads are deenergized. When the measured variable is higher than the high set-point index, a **high** control load is energized to lower the measured variable. The band between the low and high set-point indexes is called the **off** band and is adjustable from 0 to 100% of the total range of the instrument.

5. LNH Control. When the measured variable is lower than the low set-point index, a **low** control load is energized to raise the measured variable. When the measured variable is between the low and high set-point indexes, a **normal** control load is energized to maintain the normal value of the measured variable. When the measured variable is higher than the high set-point index, a **high** control load is energized to lower the measured variable. The band between the low and high set-point indexes is called the **normal** band and is adjustable from 0 to 100% of the total range of the instrument.

6. L or H Control with Proportional Input. This type of control is called "average-position action" in which the final control element is turned on and off continuously when the measured variable is within the control band. The ratio of **time on** to **time off** is directly proportional to the deviation of the measured variable from the set-point index. The set-point index usually locates the center of the control band. The control band is adjustable from 0 to 6% of the scale range.

Note: The load or loads may be

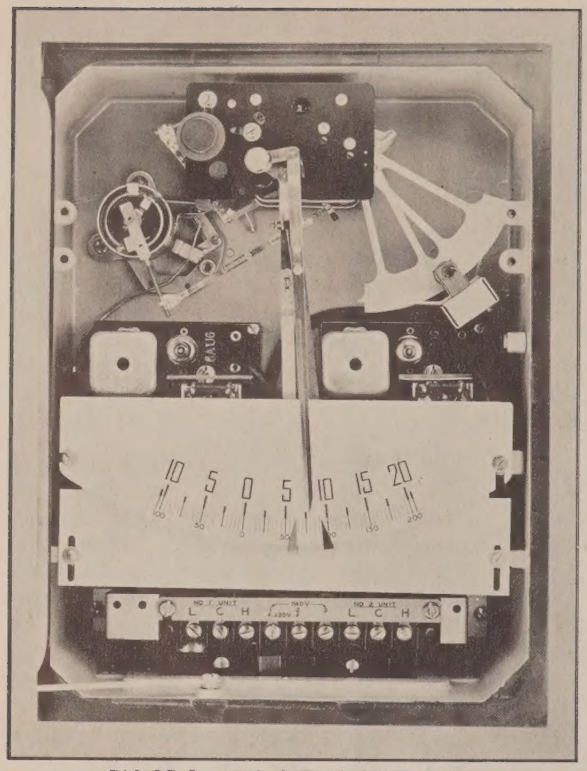


FIGURE 3. INDICATING CONTROLLER WITH TWO CONTROL UNITS

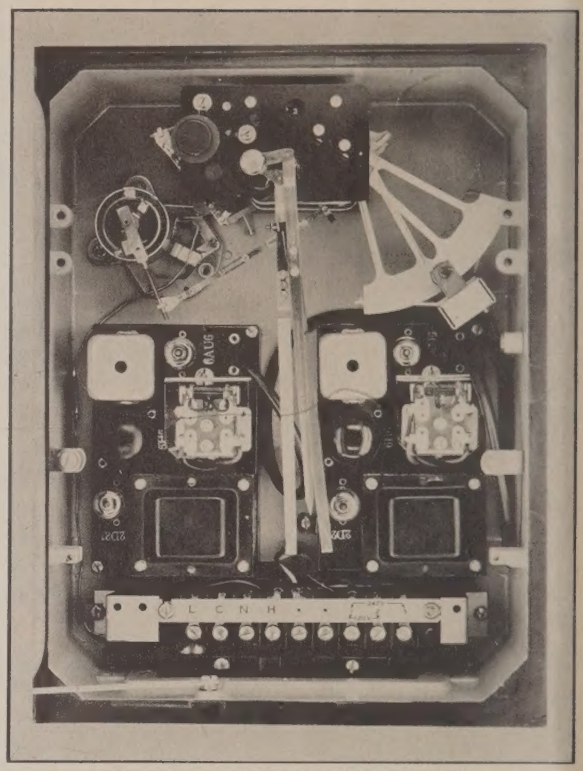


FIGURE 4. INDICATING CONTROLLER WITH TWO CONTROL UNITS

heater units, solenoid valves, coils of motor starters, relays, contactors, etc. Controllers with proportional-input control may be used as L, H or LH controllers merely by putting the band-width adjusting screw on the proportional-input unit in the zero-band position.

C. How the Electronic Control Unit Works

The measuring element of the instrument is connected to a differential mounting to actuate the pen or pointer and a vane. When this vane moves between two control coils, a change occurs in the electronic control circuit that actuates the control relay. The circuit is designed to have the control relay energized when the vane is out of the coils and deenergized when the vane is between the coils. A stop is provided on the control-coil assembly to prevent the vane from going completely thru the coils.

In case of failure of any of the tubes or of failure of the power supply to the instrument, the controller will operate as follows:

On L, H or LH controllers, the controller will operate as though the pen or pointer were above the set point, L circuit open, H circuit closed (control relay deenergized).

On LOH or LNH controllers:

1. If the low control unit fails and the high control unit is OK, the instrument will function as an "LH" controller.

2. If the high control unit fails and the low control unit is OK, the H circuit will close and the L and N circuits will open. This condition will remain until the fault has been corrected.

3. If both control units fail, operation will be the same as in 2 above.

D. How the Proportional-input Unit Works

The proportional-input unit is used together with a single electronic control unit.

The input unit consists of a variable capacitor operated by a Telechron motor. Because the variable capacitor is connected in parallel with the control coils, variation of this capacitance produces the same effect as motion of the vane between the control coils, energizing and deenergizing the control relay.

An adjustable inductance coil is connected across the variable capacitor for adjusting the location of the control point so that the control relay of the electronic control unit will operate when

the pen or pointer coincides with the set-point index in the 0% band position.

The slotted arm on the input unit has positions to give control-band widths of 0%, 1.5%, 3%, 4.5% and 6% of full range of the controller. These percentage values are approximate values because of certain differences between recorders, indicators and program controllers.

When the proportional band is adjusted to zero, the plates of the variable capacitor will remain stationary, the proportional-input unit will have no effect and two-position control will be produced.

When the control band is adjusted to 6%, the proportional-input unit will have its maximum effect.

The effect of moving the plates in the variable capacitor is to swing the control point back and forth once every revolution of the input unit.

The magnitude of this swing and the resulting control-band width depend on the setting of the adjustment mentioned above. As long as the value of the controlled variable is such as to hold the leading edge of the vane within this control band, the final control element will be opened and closed once every revolution. The proportion of opened time to closed time will then depend on the position of the vane edge within this control band. For all values of the controlled variable that are above or below the edges of this control band, the control valve (or other final control element) will be either fully closed or fully open.

PART II INSTALLATION

A. Unpacking and Mounting

See separate instructions furnished covering unpacking and mounting of the Series 500 instruments.

B. Measuring System

See separate instructions covering installation of the measuring system.

C. Wiring

Before making any connections to the instrument, determine what type of control you have (see paragraph B on page 3) and then select the correct diagram from those furnished with this instruction. Special diagrams will be furnished when required. The name plate of the instrument shows what voltage and frequency are to be connected to the a-c power terminals. Note that there are terminals for either 120 volts or 240 volts. Be sure to use the correct terminals. It is suggested that all wiring to the instrument be put in conduit.

Rating of Control Relay Contacts. The relay contacts in the control unit are limited to a non-inductive capacity of 15 amperes at 120 volts, 25, 50 or 60 cycles, 6 amperes at 240 volts, 25, 50 or 60 cycles, and 0.4 ampere at 120 volts d-c.

PART III OPERATION

A. How to Start Controllers

1. Turn instrument power supply on and allow approximately 30 seconds for tubes to warm up.
2. Move set-point index or indexes to the desired value on the chart or scale.
3. Turn load-circuit power supply on. Instrument will then begin automatic control.

B. How to Start Controllers with Proportional-input Control

Controllers with proportional-input control require several operational considerations in addition to those for the standard controller. These are the selection of the correct change gears for the proportional-input unit, the determination of the correct proportional-band width and the starting of the proportional-input unit.

1. Selection of the Correct Change Gears. Change gears are available for three different speeds of rotation of the crank arm: a 15-second cycle, a 30-second cycle and a 60-second cycle. Your proportional-input unit is provided with one set of gears as ordered. Orders that do

not specify any particular speed of rotation will be supplied with gears for a 30-second cycle.

The correct speed depends on the maximum speed with which the controlled variable can change. Use fast gear speeds for a process that can change quickly, such as a small capacity tank, furnace or vat with a relatively large input. Always use the slowest speed which will give satisfactory control. This prevents excessive wear on relays, valves, contactors, etc. However, if too slow a speed is used, the controlled variable will tend to cycle in phase with the proportional-input unit.

See paragraph D on page 8 for instructions on how to install change gears.

2. Determining the Proportional-band Width. The proportional band may be set at 0%, 1.5%, 3%, 4.5% and 6% of the full range of the instrument. This is done by moving the proportional-band-width adjusting screw to any desired position. These positions are shown in Figure 5.

To determine the correct band width for your process, proceed as follows:

First turn instrument power supply **on** and turn input-unit switch **off.** Put the band-width adjusting screw in the 6% position and then turn input-unit switch **on.** Move set-point index to the desired value on the scale. Turn load-

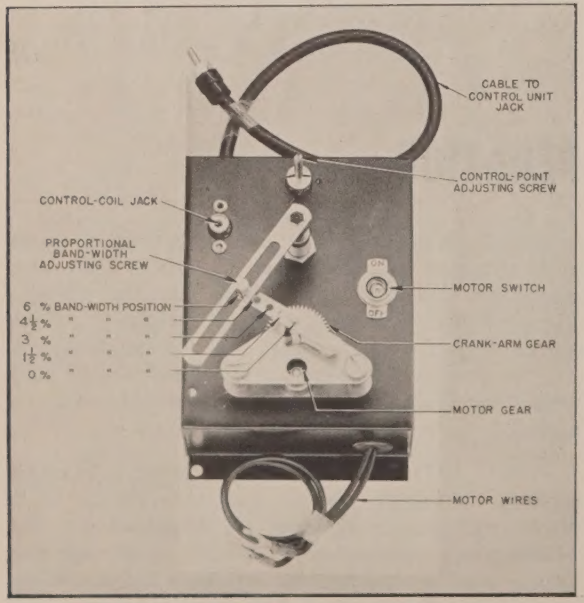


FIGURE 5. PROPORTIONAL INPUT UNIT

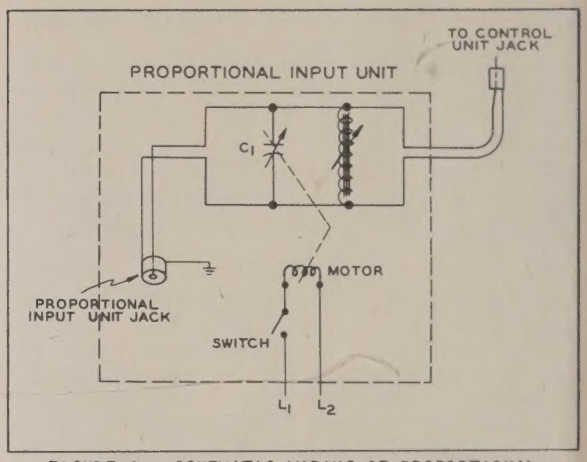


FIGURE 6. SCHEMATIC WIRING OF PROPORTIONAL INPUT UNIT

circuit power supply **on** and allow process to come to a steady condition. When the pen or pointer approaches the set point, automatic proportional control will begin. Observe the action of the pen or pointer for several minutes. The following conditions are possible:

a. The pen or pointer may come up to the control point and remain there. This indicates good control. However, it is desirable to have as narrow a proportional band as possible. Switch off the input unit and change the proportional-band width to 4.5%. Turn on the input unit and again observe the control action. If it is as stable as it was with the 6% band, continue to reduce the proportional-band width until undesirable cycling occurs. This will be indicated by oscillation of the pen or pointer from one side of the control point to the other. To eliminate this oscillation, change the proportional-band width to the next higher value and leave it there.

b. The pen or pointer may cycle in phase with the crank arm when the proportional-band width is set at 6%. This would indicate that the crank-arm speed is too slow for the particular application. Change to a faster speed (see paragraph D on page 8).

c. The pen or pointer may cycle at a frequency different from the crank-arm frequency (usually much slower). This would show that the proportional band is too narrow and that the application of the controller to this particular process was incorrect or that valve sizes, pipe sizes, etc., should be changed.

C. Checking and Adjusting the Control Point

1. Controllers without Proportional-input Control. The control relay should operate when the pen or pointer coincides with the set-point index. This adjustment is very accurately made at the factory and seldom requires readjustment. If readjustment is necessary, turn the control-point adjusting screw (see Figure 1) a little to the left or right as required.

2. Controllers with Proportional-input Control. Remove plug-in cables from control unit and input unit. Plug cable from the control coils directly into the control unit and check the control point exactly as in paragraph 1 above. Then replace plug-in cable from control coils to input unit and plug-in cable from input unit to control unit. Adjust the proportional-band-width adjusting screw in the zero hole of the crank arm so that the slotted arm remains perfectly vertical. Again check the control point exactly as in paragraph 1 above. If any adjustment is necessary, adjust the control-point adjustment on the proportional-input unit (not the control-point adjustment on the control unit).

D. Checking and Adjusting the Differential Gap

Differential gap (dead zone) applying to two-position controller action (LH control) is the smallest range of values thru which the controlled variable must pass in order to move the final control element in succession to both of its fixed positions. This zone is set at the factory at approximately .003" and seldom requires readjustment. However, when the instrument is subject to excessive vibration, it may be necessary to widen the differential gap in order to prevent erratic operation of the controller.

To check the width of the differential gap, move the set-point index slowly past the pen or pointer (both upscale and downscale) and note when the control relay operates. If readjustment is required, it may be done by adjusting the differential-gap adjustment (see Figure 1) with a screwdriver. Turn the adjusting screw counterclockwise to widen the differential gap or clockwise to narrow the gap. Check the control point after any change in the differential gap.

Control units shipped after June 1, 1954 permit a differential-gap adjustment up to .012". Control units made previous to this date have a maximum gap of approximately .004". These older units may be easily altered in the field to permit a wider differential gap by adding a 270,000 ohm resistor (Bristol Part 90557) across the discriminator transformer secondary (lugs A and C on schematic wiring diagram)

PART IV SERVICE

A. Checking the Tubes

If your controller fails to function properly and there is no obvious fault (such as power failure, measuring-element failure, etc.), check the electronic tubes by replacement (a spare set should always be kept on hand). Remove one tube at a time from the control unit and replace it with one known to be good. Allow 30 seconds for the tube to warm up. When operation is restored, the original good tubes may be reinstalled. If normal operation is not obtained with a complete new set of tubes, the control unit should be replaced by one known to be good. When replacing a unit, leave the old tubes in the old unit.

Note: The vacuum tubes used are standard types and may be purchased in any radio supply store.

B. Replacing a Control Unit

To remove a control unit, disconnect the wires connecting the unit to the terminal block and remove the plug-in cable from the control coils or input unit as the case may be. After removing the mounting screws, the unit may be easily removed from the case. Install the new unit, replace and tighten the mounting screws and connect the wires as per wiring diagram.

After the new unit has been installed, check its control point and differential gap as outlined in Part III, paragraphs C and D.

C. Servicing of Relay Contacts

The relay contacts should be cleaned and burnished (with crocus cloth) as often as experience shows it to be necessary.

Crank-arm Rotation (Seconds)	Crank-arm Gear		Motor Gear	
	Number Of Teeth	Part Number	Number Of Teeth	Part Number
15	30	67856	30	67856
30	40	47693	20	47696
60	48	45319	12	53490

FIGURE 7. TABLE OF GEARS FOR INPUT UNIT

D. How to Install Change Gears on Proportional-input Units

To install new change gears, remove the proportional-band adjusting screw (note which hole it is in), swing the slotted arm out of the way and take off the top bearing plate (including the crank arm, shaft and gear). Remove the crank-arm gear and motor gear. See Figure 7 for identification and listing of gears.

For a 15-second cycle the two change gears have an equal number of teeth (30). For the 30- and 60-second cycle the larger gear always goes on the crank-arm shaft. After sliding the new gears on their respective shafts, replace the top bearing plate. Position the crank-arm gear on its shaft so that it clears the bottom bearing plate by at least 1/16". Tighten its setscrew. Then position the motor gear so that it meshes properly with the crank-arm gear. Tighten its setscrew. Replace the proportioning-band adjusting screw in the same hole from which it was originally removed.

E. Repairs, Correspondence and Shipping

If your electronic controller cannot be repaired with the information furnished in this instruction, it should be shipped to the nearest Bristol Company Branch or Main Factory for repair or replacement. **Do not** ship instrument to Branch Offices.

Send all parts for repair or exchange to Branch or Main Factories only, never to Branch Offices. Identify your shipment fully, including your exact return address and repair order number.

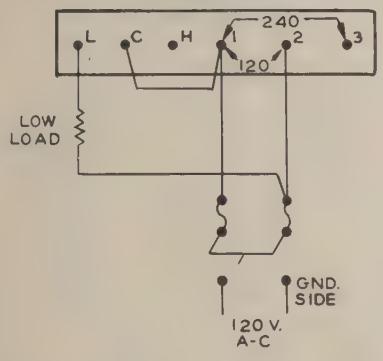
Send all correspondence and orders to the nearest Branch Office. Addresses and phone numbers of Bristol's Field Organization are listed on last pages of all instruction books.

Be sure to state model and serial number of instrument in all orders and correspondence.

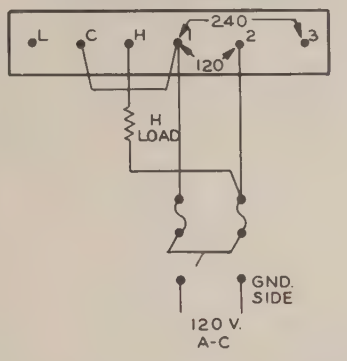
The Bristol Company
Waterbury 20, Conn.

Printed in U.S.A.

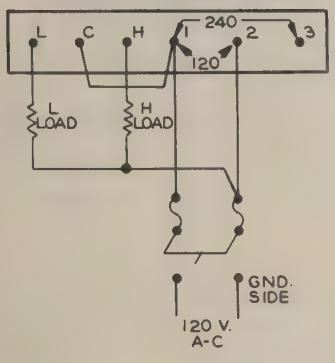
L-TYPE CONTROL



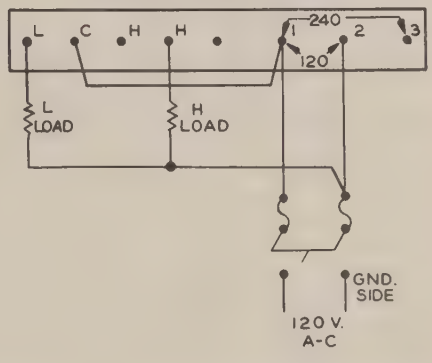
H-TYPE CONTROL



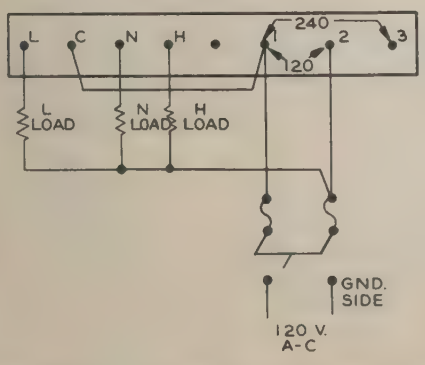
LH-TYPE CONTROL



LOH-TYPE CONTROL



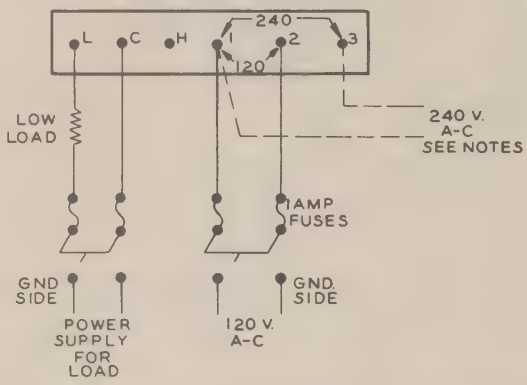
LNH-TYPE CONTROL



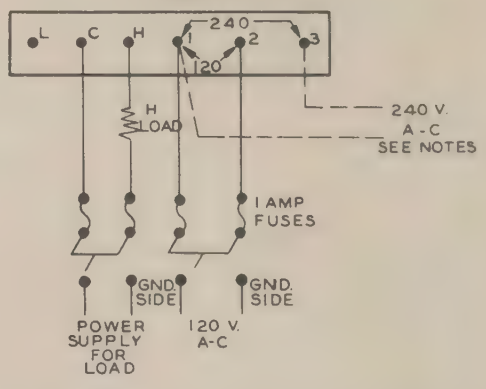
NOTES:-
1. FUSED LINE SWITCHES FURNISHED BY CUSTOMER.
2. LOAD CIRCUIT CONTACTS IN CONTROLLER ARE LIMITED TO A NON-INDUCTIVE CAPACITY OF 15 AMPS. AT 120 V. A-C OR 6 AMPS. AT 240 V. A-C

EXTERNAL WIRING DIAGRAM
SERIES 500 ELECTRONIC CONTROLLERS
WITH COMMON 120 V. A-C SUPPLY FOR INSTRUMENT AND LOADS

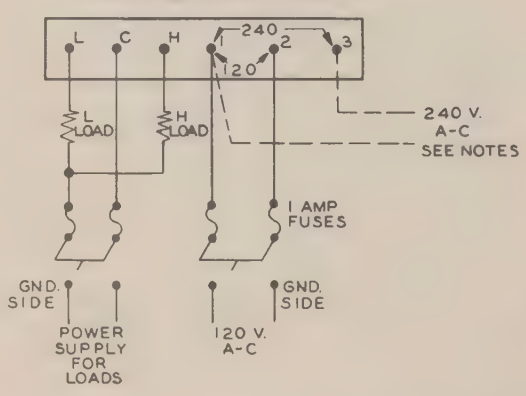
L-TYPE CONTROL



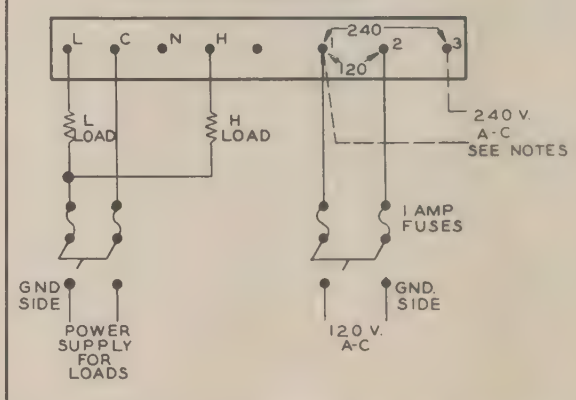
H-TYPE CONTROL



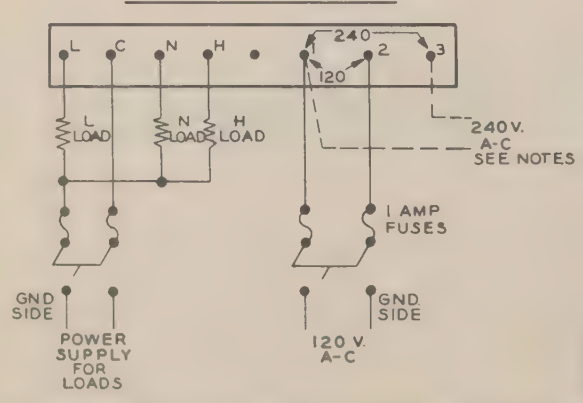
LH-TYPE CONTROL



LOH-TYPE CONTROL



LNH-TYPE CONTROL

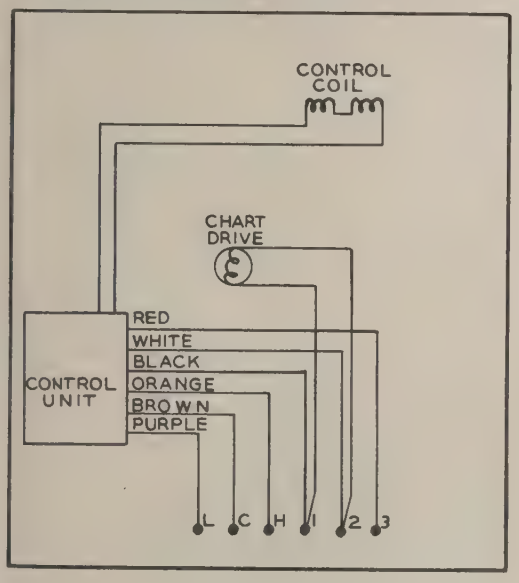


NOTES:—

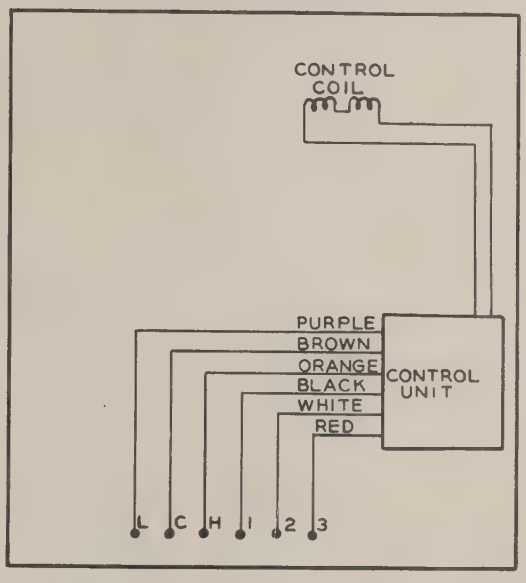
1. THE POWER SUPPLY TO THE CONTROLLER MAY BE EITHER 120 VOLTS OR 240 VOLTS A-C.
2. FUSED LINE SWITCHES FURNISHED BY CUSTOMER.
3. LOAD CIRCUIT CONTACTS IN CONTROLLER ARE LIMITED TO A NON-INDUCTIVE CAPACITY OF 15 AMPS. AT 120 V. A-C OR 6 AMPS. AT 240 V. A-C.

EXTERNAL WIRING DIAGRAM
SERIES 500 ELECTRONIC CONTROLLERS
WITH SEPARATE SUPPLY FOR INSTRUMENT AND LOADS

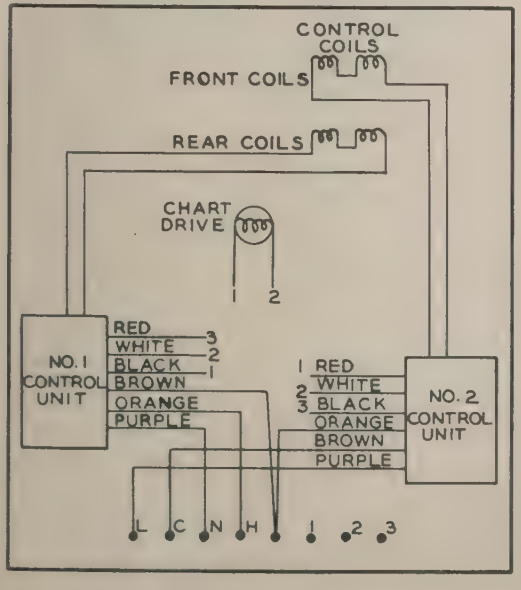
RECORDER WITH SINGLE CONTROL UNIT



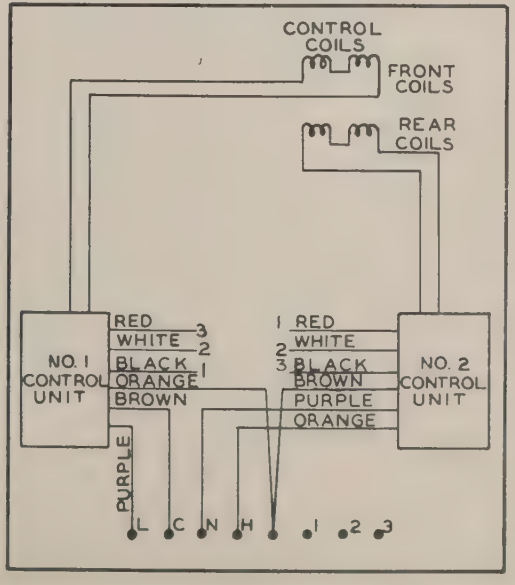
INDICATOR WITH SINGLE CONTROL UNIT



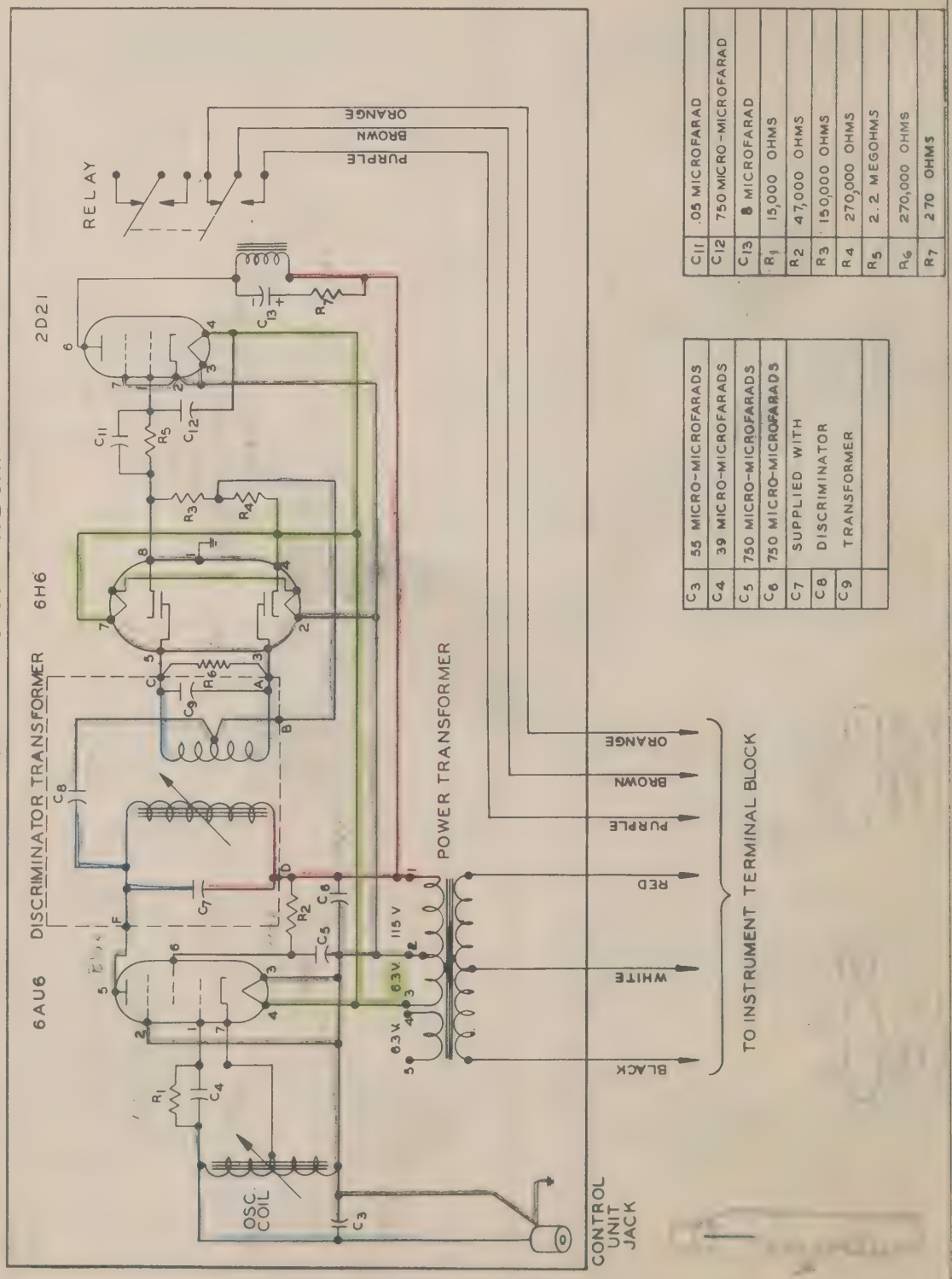
RECORDER WITH TWO CONTROL UNITS



INDICATOR WITH TWO CONTROL UNITS



INTERNAL WIRING DIAGRAMS



C_3	55 MICRO-MICROFARADS
C_4	39 MICRO-MICROFARADS
C_5	750 MICRO-MICROFARADS
C_6	750 MICRO-MICROFARADS
C_7	SUPPLIED WITH
C_8	DISCRIMINATOR
C_9	TRANSFORMER

C_{11}	.05 MICROFARAD
C_{12}	750 MICRO-MICROFARAD
C_{13}	8 MICROFARAD
R_1	15,000 OHMS
R_2	47,000 OHMS
R_3	150,000 OHMS
R_4	270,000 OHMS
R_5	2.2 MEGOHMS
R_6	270,000 OHMS
R_7	270 OHMS

SCHEMATIC WIRING OF CONTROL UNIT

INSTRUCTION NO. T8000A

(Issue No. 2 of 6/53)

UNPACKING, INSTALLATION AND SERVICE OF FILLED SYSTEM THERMOMETERS

Note: This instruction covers only the temperature measuring system. See separate instructions for installing the case, operation of the recording or controlling system, etc.

TABLE OF CONTENTS

	Page
PART I GENERAL	2
A. Description of Filled System Thermometers	2
B. Name Plate Data	2
C. Type of Bulb to Use	3
PART II INSTALLATION	3
A. Installing the Case	3
B. Installing Tubing	3
C. Installing Bulbs	3
1. Assembly	3
2. Amount of Immersion	5
3. Plain Bulbs	5
4. Union Bulbs	5
5. Well Bulbs	5
6. Bendable Extension	5
7. Installation Thru Conduit and Partitions	5
8. Pressure Limits of Convertible Bulb	5
D. Factors Affecting Thermometer Performance	6
1. Bulb Location	6
2. Bulb and Well Conduction	6
E. Over and Under Range Protection	7
F. Bulb Elevation Corrections	7
G. Installation of Certain Special Bulbs	12
1. Atmospheric Temperatures	12
2. Averaging Bulbs	12
3. Electroplating Baths and Tanks	12
PART III OPERATION	12
PART IV SERVICE	12
A. Checking and Calibrating	12
1. Testing for Friction	12
2. Cautions for Calibration or Checking	13
3. Checking and Calibrating Procedure	13
4. Calibrating Temperatures	17
B. Replaceable Thermometer Systems	17
1. Changing Ranges	17
2. Standby Thermometer Systems	17
3. How to Remove Thermometer Systems	17
4. How to Install Replacement Thermometer Systems	17
5. How to Order Replacement Thermometer Systems	18
C. Lubratication and Cleaning	18
D. Repairs, Correspondence and Shipping	18

THE BRISTOL COMPANY WATERBURY 20, CONN.

Note: This instruction applies to all Class 1, 2 and 3 case or fully compensated, single and multiple thermometer systems as used in indicating, recording and controlling thermometers, or as temperature pens in pressure gauges, flowmeters, etc.

If your instrument is an indicating instrument, please ignore any reference herein to chart, pen, etc.

PART I GENERAL

A. Description of Filled System Thermometers

The thermometer system consists of the helical pressure element, connected by flexible capillary tubing to a metal chamber or bulb (see Figure 1). The bulb, tubing and pressure element form a sealed pressure system which is factory filled with a fluid dependent upon the class of thermometer system. Bristol Company thermometer systems are classified into three main categories and are in accord with the standards set up by the Scientific Apparatus Makers Association:

Class 1 - Liquid filled systems
Class 2 - Vapor pressure systems
Class 3 - Gas filled systems

This sealed pressure system must never be opened or broken because the filling fluid will leak out, even thru the most minute crack or hole, making the system inoperative.

Pressure changes or expansion of the filling fluid occurs when temperatures at the bulb change. These changes are transmitted by the capillary tubing to the pressure element, causing the element to coil or uncoil, thus moving the pen or pointer thru the connecting linkage.

B. Name Plate Data

The name plate mounted inside the door carries the following information:

1. Model Number. The model number is given in full. The class of thermometer system is given by the number following the first dash after the basic model number. For example, Model No. 1T500-2B-E4. The "2B" indicates the class of thermometer system. A complete breakdown of the three classifications follows:

1A - Class 1, liquid filled system, fully compensated.

1B - Class 1, liquid filled system, case compensated.

2A - Class 2, vapor pressure system, to operate with the measured temperature above the temperature of the rest of the thermal system.

2AL - Class 2, vapor pressure system, linear conversion, to operate with the measured temperature above the temperature of the rest of the thermal system.

2B - Class 2, vapor pressure system, to operate with the measured temperature below the temperature of the rest of the thermal system.

2BL - Class 2, vapor pressure system, linear conversion, to operate with the measured temperature below the temperature of the rest of the thermal system.

2C - Class 2, vapor pressure system, to operate with the measured temperature above and below the temperature of the rest of the thermal system.

2CL - Class 2, vapor pressure system, linear conversion, to operate with the measured temperature above and below the temperature of the rest of the thermal system.

2D - Class 2, vapor pressure system, dual filled, to operate with the measured temperature above, below and at the temperature of the rest of the thermal system.

2DL - Class 2, vapor pressure system, dual filled, linear conversion, to operate with the measured temperature above, below and at the temperature of the rest of the thermal system.

3A - Class 3, gas filled system, fully compensated.

3B - Class 3, gas filled system, case compensated.

2. Bulb Number. The first three number groups give the bulb specifications, the last group gives the length of the tubing in feet.

3. Bulb Elevation. (Class 2 only) If the thermometer has been ordered corrected for levels, the elevation of the bulb above or below the instrument, measured to the bottom of its case, will

be given. If these spaces are blank, no correction has been made. See paragraph F on page 7 for full explanation of correction for levels.

C. Type of Bulb to Use

1. Plain Bulbs. (See Figure 2) Plain bulbs can be used where a pressure tight joint is not necessary.

2. Union Bulbs. (See Figure 3) Union bulbs are used where a pressure tight joint is necessary.

3. Well Bulbs. (See Figure 4) Bulbs with wells are used for the following reasons:

a. Protect bulb from corrosion.

b. Protect bulb from high pressure, mechanical damage or erosion.

c. Permit removal of bulb from process without necessity of turning process off. Wells should always be used where process cannot be shut down at any time for removal of bulb for check, calibration, repair or replacement.

PART II INSTALLATION

Caution: Handle thermometer tubing and bulb with care. Do not twist, kink or strain tubing. Do not bend it sharply. Never cut tubing or disconnect it from bulb or case coupling. Never use tubing to carry or support the instrument.

A. Installing the Case

See separate instructions furnished, covering unpacking and mounting of the instrument. Thermometers must be mounted exactly plumb. Use a spirit level on inside bottom of case, or a plumb bob along front edge. Locate case to avoid extremes of temperature.

In flush mounting bottom connected thermometers on thick panels, it may be necessary to increase the length of panel cutout to provide clearance for tubing.

B. Installing Tubing

Uncoil tubing and carefully straighten it out without twists or kinks. Do not cut it under any circumstances. Do not bend tubing at less than a 3" radius. The tubing must be protected from mechanical damage, crushing, abrasion, strain or movement. Tubing may be strung thru conduit if bulb is small enough to pass thru it. Tubing may be supported on any wall, beam, etc., by fastening every 2 feet with clips, staples, etc. Tubing may be tied or taped to unheated pipes, columns, etc.

Do not subject tubing covered with polyvinyl chloride plastic to temperatures over 160°F (71°C) or it will melt.

Class 1 and 3 uncompensated tubing must be installed to avoid extremes of temperature. Keep tubing away from hot or cold pipes, ovens, chimneys, hot or cold air ducts, open windows, direct sunlight, etc. Class 2 tubing is relatively unaffected by ambient temperatures.

Coil any excess of tubing in an 8" to 12" coil near the instrument and tape it in place. **Do not cut off excess tubing.**

C. Installing Bulbs

The Bristol convertible thermometer bulb can be easily changed to plain, union or well type bulb by exchanging union and well parts. Thus, one basic bulb can fulfill requirements of almost all processes. This feature permits standardization of thermometer systems to a single basic bulb specification throughout an entire plant, which allows quick replacement of a faulty system by standardized standby thermometers.

1. Assembly. Figure 5 shows correct order of part assembly. To change from plain (Figure 2) to union bulb (Figure 3), the parts shown in Figure 5 are added to the plain bulb. To change from union to well bulb, replace union bushing with the well.

All parts can be slipped over the sensitive portion of bulb, except the packing and glands which are split so they can be opened to slip over the extension. Halves of split glands are held together by spring-wire gland clips. All bulb conversion parts are specified in "Parts List for Thermometer Accessories" included with each instruction book.

Caution: In tightening packing nut, be very careful not to mar the polished seat of union plug. A damaged union seat

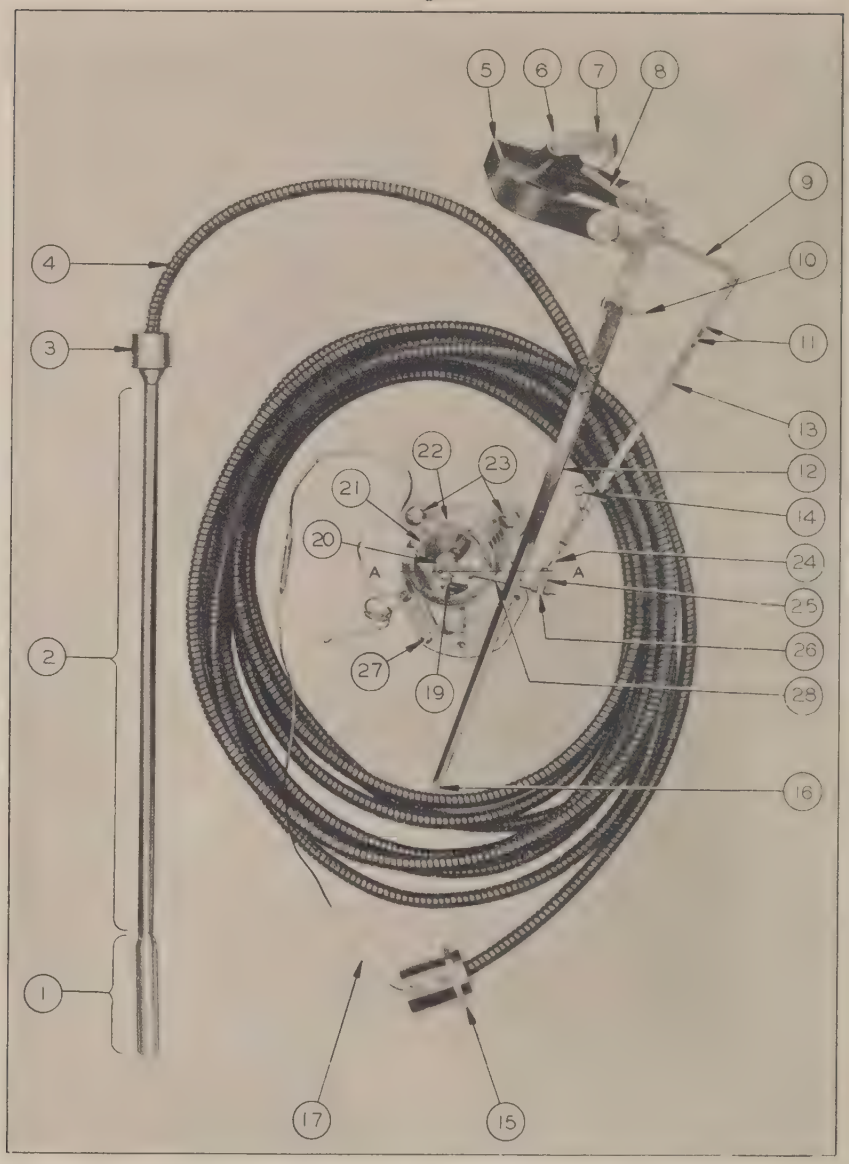


FIGURE I TYPICAL THERMOMETER SYSTEM

CODE TO FIGURE I

1. Sensitive portion of bulb
2. Extension
3. Connector
4. Flexible armor
5. Pen mounting
6. Pen mounting screws
7. Overrange pen stop (optional)
8. Pen stop lever (optional)
9. Pen shaft lever
10. Point micro adjuster
11. Connecting link adjustment screws
12. Pen arm
13. Connecting link
14. Expansion link spring
15. Case connection fitting
16. Recording pen
17. Capillary tubing
18. Element mounting bracket
19. Split hub setscrew
20. Split hub
21. Bimetallic case temperature compensator (not used in Class 2 or fully compensated systems)
22. Thermometer pressure element
23. Element mounting-bracket screws
24. Connecting link tab
25. Span adjuster lock screw
26. Span adjuster
27. Element mounting screws
28. Threaded lever

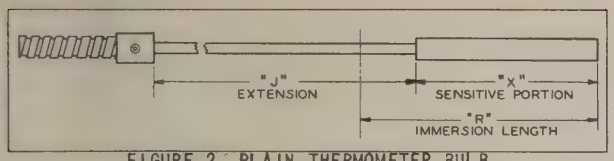


FIGURE 2 PLAIN THERMOMETER BULB

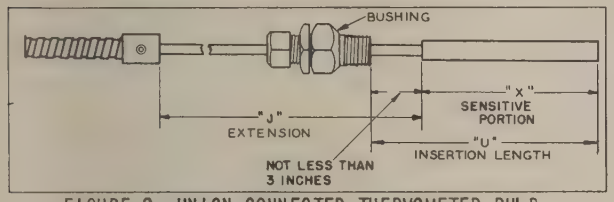


FIGURE 3 UNION CONNECTED THERMOMETER BULB WITH BUSHING

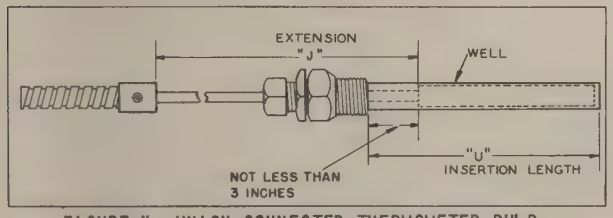


FIGURE 4 UNION CONNECTED THERMOMETER BULB WITH WELL

will leak. Use only a flat high quality open-end wrench of exact size as hex section of the union plug. **Do not use pipe or monkey wrenches.**

2. Amount of Immersion. Convertible bulbs are factory calibrated with sensitive portion "X" and 3 inches of extension "J" covered by test bath. **The entire sensitive portion "X" of bulb plus 3 inches of extension "J" must be covered by the medium being measured.** If this is not done, the thermometer will not read correctly. If more than 3 inches of the extension is immersed in the medium being measured, slight errors may occur in some types of systems. If specified on the order, convertible bulbs will be calibrated with any length of extension immersed.

Where the amount of immersion is constantly changing, the bulb should be calibrated for the average immersion. See Part III, paragraph A for full calibrating instructions.

Caution: Do not immerse flexible armor even momentarily in corrosive mediums, for the medium will penetrate joints in armor and destroy the capillary tubing.

3. Plain Bulbs. Plain bulbs can be most easily held by clamping at the bulb connector (see Figures 6, 7, 8 and 10). They can be suspended by wire or light chain or slipped into protection wells (see Figure 11).

4. Union Bulbs. Union bulbs can be installed thru a tank or oven wall as in Figures 9 and 12, or in pipe elbows or tees as in Figure 14 or 15. To install, insert union bushing in the process and screw up tight. Then, insert bulb and screw up jam nut tight, being careful not to twist tubing as jam nut is turned.

Caution: Be careful not to mar the seat on the union plug. A damaged seat will leak. Do not use toothed pipe wrenches.

5. Well Bulbs. Well bulbs can be installed in a tank wall, pipe elbow or tee, see Figure 13 or 16. To install, screw well tightly into process. Then, insert bulb into well and tighten jam nut, being careful not to twist tubing as nut is turned.

6. Bendable Extension. The 1/4 inch diameter extension (J in Figure 2 or 5) is standard in 10, 30 and 60 inch lengths. This extension can be bent, either inside or outside the process to clear pulleys, levers, stirring paddles, sliding doors, etc., to suit the installation. Minimum radius of bend must be not less than 1 inch. Bend extension around a pipe of the proper diameter to avoid flattening the extension. See Figures 7, 9, 10 and 11 illustrating the use of the bendable extension feature.

7. Installation Thru Conduit and Partitions. It is possible to install tubing thru 3/4 inch conduit pipe for protection, or to pull tubing thru 3/4 inch holes in partitions or floors because all union and well parts can be removed from convertible bulbs, leaving as the largest part on all but a few types the 3/4 inch diameter connector.

8. Pressure Limits of Convertible Bulb.

a. Union connected bulb with bushing can be used with ample safety factor up to 200 pounds per square inch (14.0 kilograms per sq. cm.).

b. Wells can be safely used up to the following:

	P.S.I.	K/SQ. CM.
Bronze Wells	500	35.0
Stainless Steel Wells	750	52.6

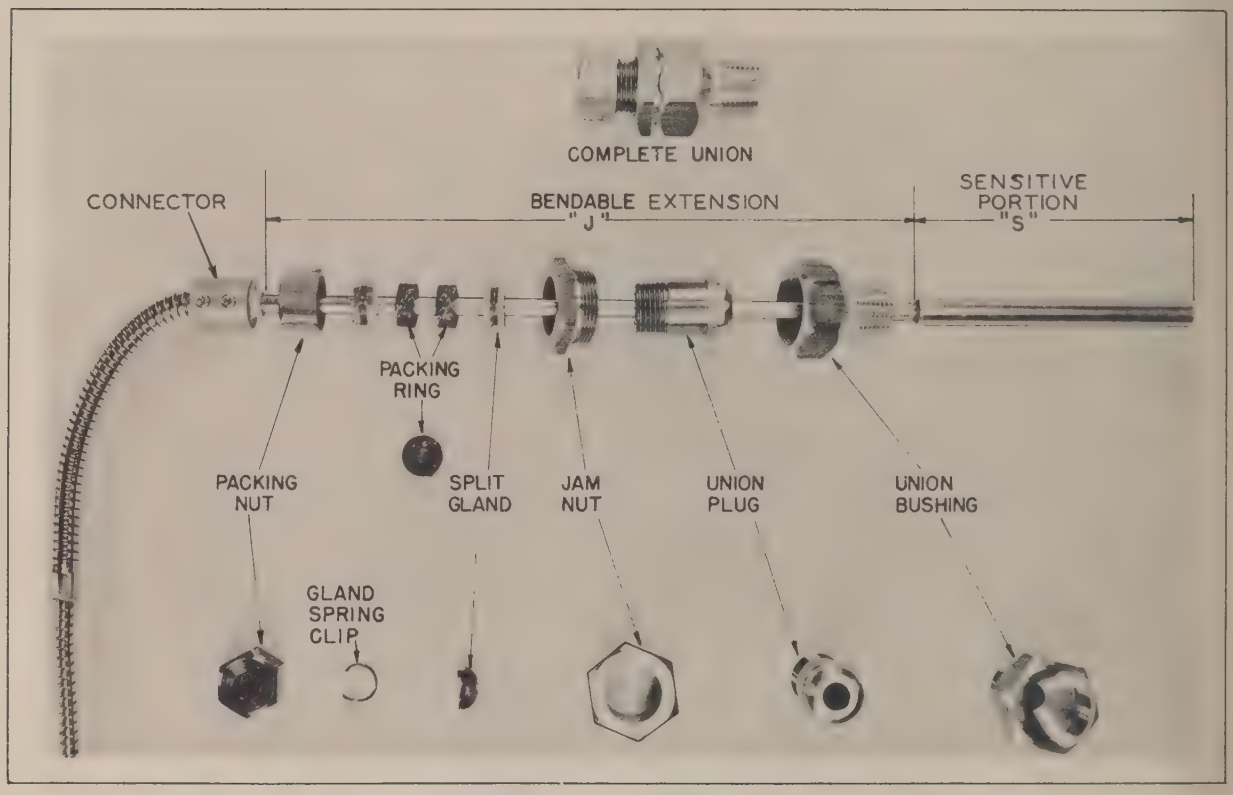


FIGURE 5 BRISTOL CONVERTIBLE BULB SHOWING CORRECT ORDER OF PARTS ASSEMBLY

D. Factors Affecting Thermometer Performance

The following considerations are especially important where temperature critical processes are involved, and for controlling thermometers:

1. Bulb Location

a. Representative Temperatures. In selecting the bulb location, consider what temperature of the process you want to measure, i.e., maximum, average, minimum, or input, output or interior temperature. Interior temperatures of processes, such as ovens, tanks, etc., may vary widely from point to point. Of first importance is locating the bulb so that it acquires the temperature it is desired to measure. A test to find this location can be made by moving the bulb from point to point and observing readings before making a permanent installation.

Keep bulbs away from cooling or heating duct openings or heating or cooling coils. Keep bulb away from the extreme top or bottom of ovens, rooms, etc., unless the temperature of these points is desired.

b. Circulation. Turbulence of the measured medium around the bulb should be as high as possible to increase the rate of heat transfer. Avoid locating bulbs in dead spaces, corners, dead end pipes or spots shielded from circulation. Avoid locating bulb so near the bottom of the tank or kettle that it might be partially covered by sludge or sediment.

Place bulbs near paddles, blowers, etc. Place bulbs in pipes or ducts at right angles to the flow (see Figures 13, 15 and 16).

c. Radiation Error. This is an important and usually overlooked consideration. Avoid placing bulbs where high temperature radiation from unshielded electric or steam heating coils can strike them. Avoid placing bulbs close to cold surfaces such as an uninsulated oven wall. If bulbs must be so located, place a piece of asbestos board or sheet metal between the bulb and the hot or cold surface (see Figure 7).

In general, locate the bulb to obtain good circulation, but not in the direct path of the heating or cooling agent.

2. Bulb and Well Conduction. Protec-

tion of bulbs in wells is accomplished only by great decrease in speed of response of the bulb (loss of responsiveness may be as high as 30 to 1).

The insulating effect of the dead air space between bulb and well cuts down the rate of heat transfer very much. Therefore, bulbs should fit very snugly into wells. A worthwhile increase in bulb response can be had by filling space between bulb and well with a highly conductive medium, such as water, oil, glycerine, graphite grease, mercury (only in all steel combinations), etc., depending upon the temperatures.

E. Over and Under Range Protection

(Refer to Figure 1.) As the bulb temperatures vary, internal pressures of the thermometer system change, causing the pressure element to coil or uncoil, actuating the linkage and pen arm. Considerable force is developed by the pressure element. If the bulb temperature goes above the upper limit of the temperature range or under the lower limit, the pen will attempt to follow and be swung off the chart at either end. This pen motion would eventually be stopped by the chart hub or the side of the case, probably bending the pen arm or linkage, destroying the calibration of thermometer.

To protect pen arm and linkage against such damage, adjustable stops (7) are provided to limit pen travel to little more than full range. Connecting link (13) is provided with a compression and expansion spring (14) which permits pressure element (22) to deflect after lever (8) strikes stop (7).

Bristol thermometers will be supplied with this over range and/or under range protection when so ordered. Even with such protection to the pen and linkage, the pressure element may be extended beyond its elastic limit and its calibration destroyed by excessively large over or under range temperatures. The maximum possible limits of over and under range temperature protection vary with the class of system, the range, length of tubing and ambient temperature. Please consult Sales Engineering Dept. at Waterbury factory for such data.

Caution: Never subject a thermometer bulb to temperatures over or under its range unless its system is protected. It is often overlooked that this precaution applies to many thermometers of high partial range, while instrument is in storage or shipment.

F. Bulb Elevation Corrections (Class 2 Systems Only)

(See Figure 18.) In the majority of thermometer installations, the bulb is at higher temperatures than the tubing so that the tubing will be filled with the liquid (all vapor will be in bulb). When the bulb is mounted at a level above or below the thermometer case, the weight of this liquid in vertical portions of the tubing adds to or subtracts from the pressures in the element. Because pressures in vapor filled systems are low, this plus or minus head of liquid ("h" in Figure 18) may cause a serious error in temperature readings which must be compensated for.

When bulb is mounted above the case, the weight of the liquid in the tubing will add to the pressure measured by the element, causing the thermometer to read high. To read the correct bulb temperature, the thermometer reading must be "set back".

When bulb is mounted below the case, the weight of the liquid in the tubing will subtract from the pressure measured by the element, causing the thermometer to read low. Then to read the correct bulb temperature, the thermometer reading must be "set up".

When the bulb is always colder than the tubing (bulb is always below ambient temperature), all of the fluid will condense in the bulb, leaving the tubing filled with vapor and no correction for difference in bulb and case level will be necessary (except in the dual filled Class 2D systems).

When the bulb is sometimes colder and sometimes hotter than the tubing (bulb sometimes above and below ambient temperature), the tubing will be sometimes filled with liquid and sometimes filled with vapor so that corrections for difference in bulb and case level are impossible with a Class 2C temperature system. Class 2C systems will be accurate both above and below ambient temperatures only when the bulb is approximately at the same level as the case.

When so ordered, Class 2 thermometers will be factory calibrated to correct for any specified bulb elevation. If a thermometer has been so corrected in the factory, its name plate will list the bulb elevation in feet. The difference

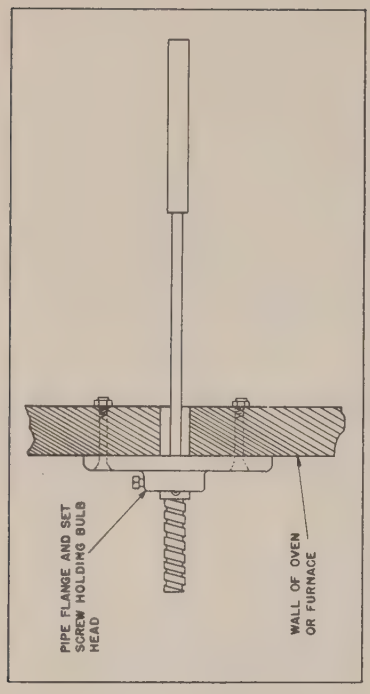


FIGURE 6 PLAIN BULB INSTALLED IN WALL OF OVEN

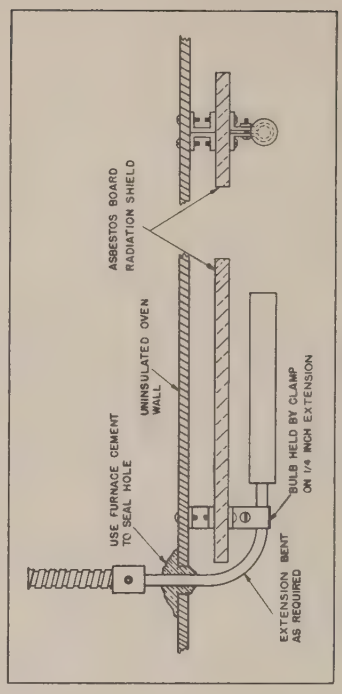

ASBESTOS BOARD RADIATION SHIELD
UNINSULATED OVEN WALL
USE FURNACE CEMENT TO SEAL HOLE
BULB HELD BY CLAMP ON 1/4 INCH EXTENSION
EXTENSION BENT AS REQUIRED

FIGURE 7 PLAIN BULB CLAMPED TO WALL OR ROOF OF OVEN SHOWING USE OF RADIATION SHIELD.

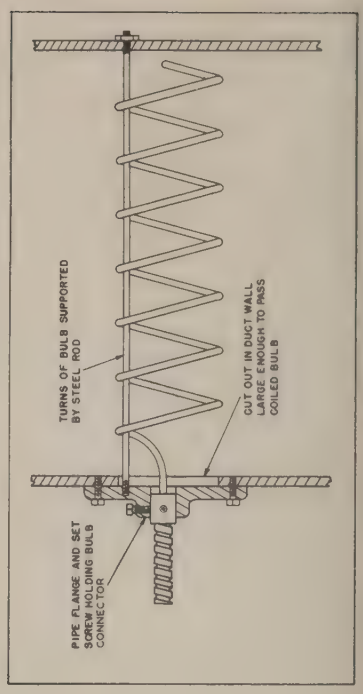

TURNS OF BULB SUPPORTED BY STEEL ROD
CUT OUT IN DUCT WALL LARGE ENOUGH TO PASS COILED BULB
PIPE FLANGE AND SET SCREW HOLDING BULB CONNECTOR

FIGURE 8 AVERAGING TYPE BULB INSTALLED IN STACK OR DUCT

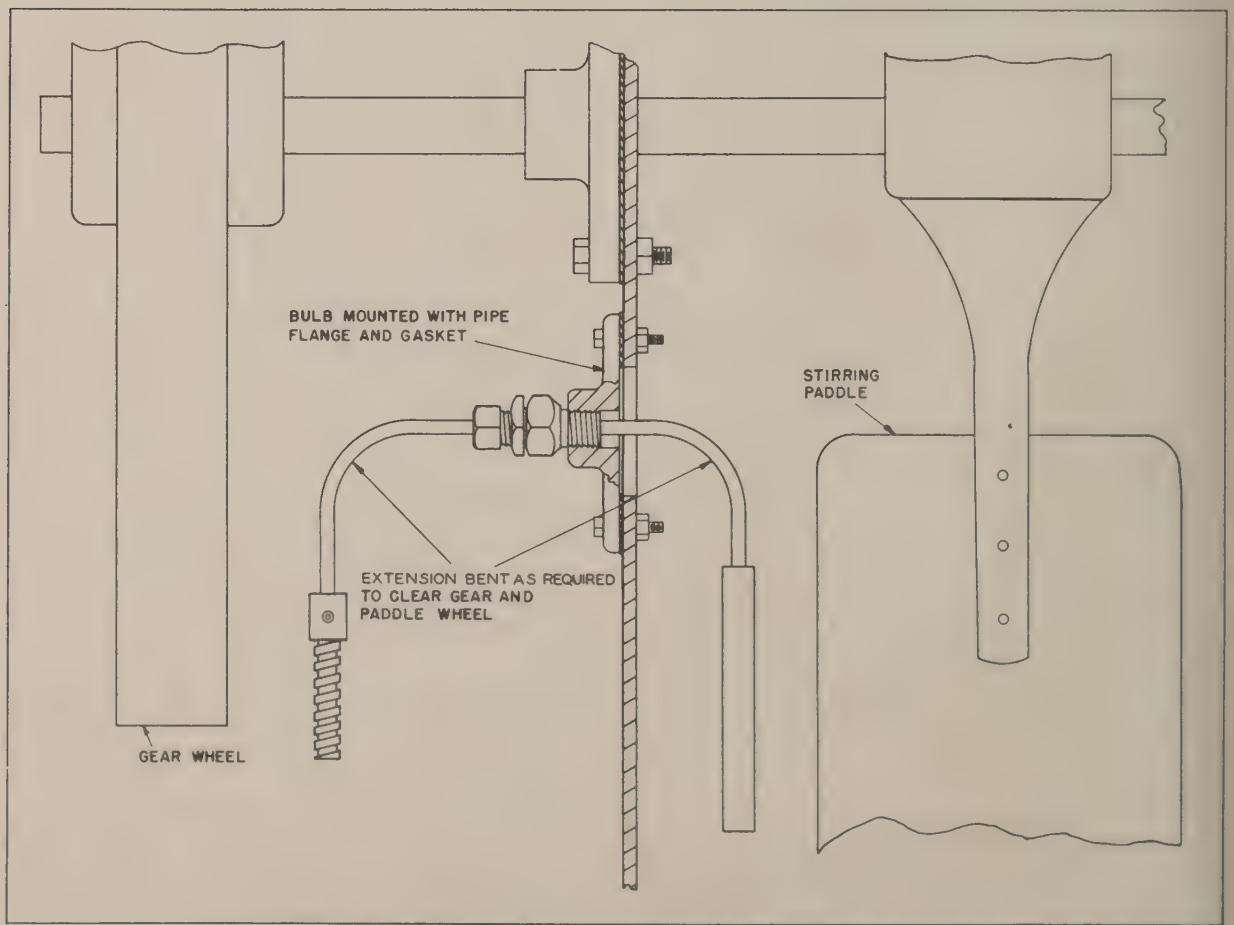

BULB MOUNTED WITH PIPE FLANGE AND GASKET
STIRRING PADDLE
EXTENSION BENT AS REQUIRED TO CLEAR GEAR AND PADDLE WHEEL
GEAR WHEEL

FIGURE 9 UNION BULB INSTALLED IN TANK SHOWING USE OF BENDABLE EXTENSION

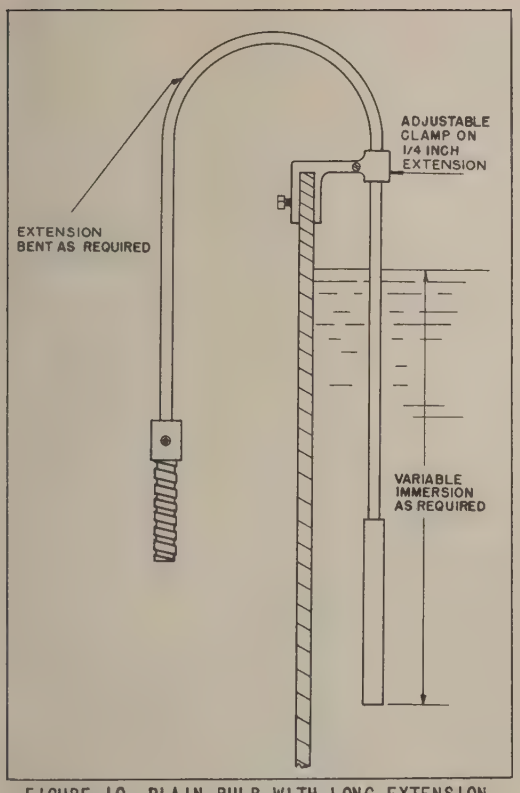


FIGURE 10 PLAIN BULB WITH LONG EXTENSION SUSPENDED BY CLAMP IN OPEN VAT OR TANK

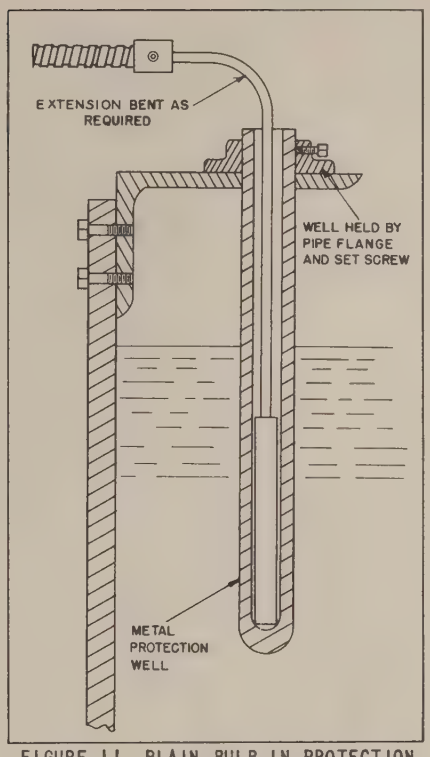


FIGURE 11 PLAIN BULB IN PROTECTION WELL FOR PROTECTION AGAINST MOLTEN METALS, CORROSIVE CHEMICALS, ETC.

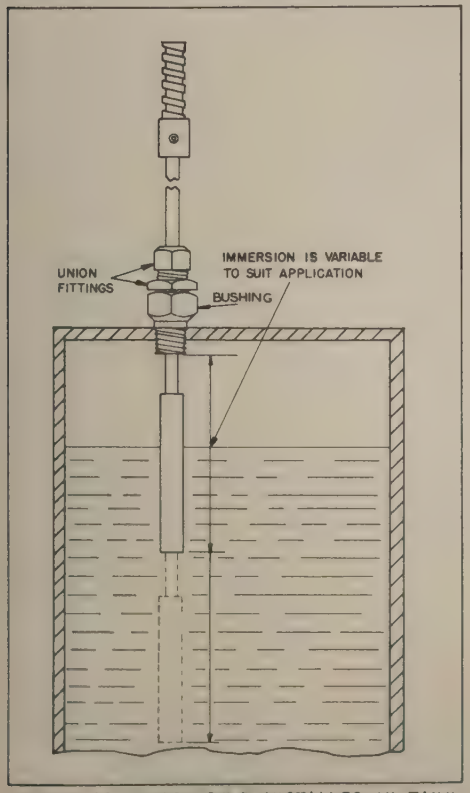


FIGURE 12 UNION BULB INSTALLED IN TANK SHOWING VARIABLE IMMERSION FEATURE

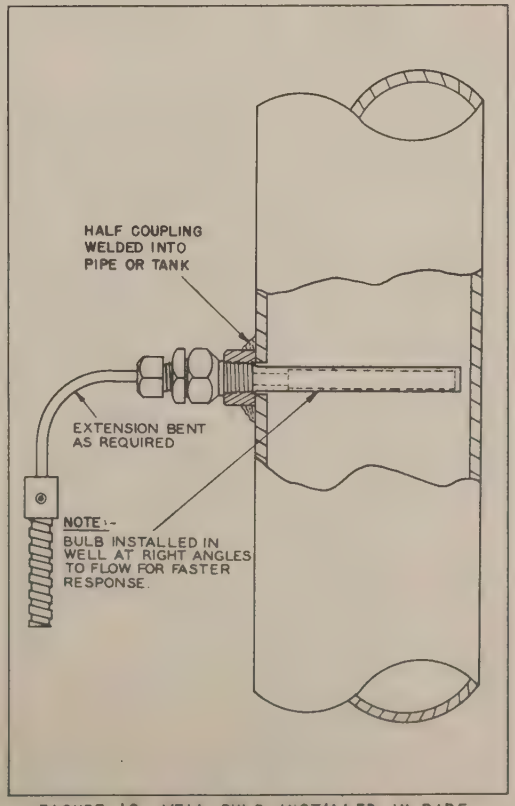

HALF COUPLING WELDED INTO PIPE OR TANK
EXTENSION BENT AS REQUIRED
NOTE:-
BULB INSTALLED IN WELL AT RIGHT ANGLES TO FLOW FOR FASTER RESPONSE.

FIGURE 13 WELL BULB INSTALLED IN PIPE

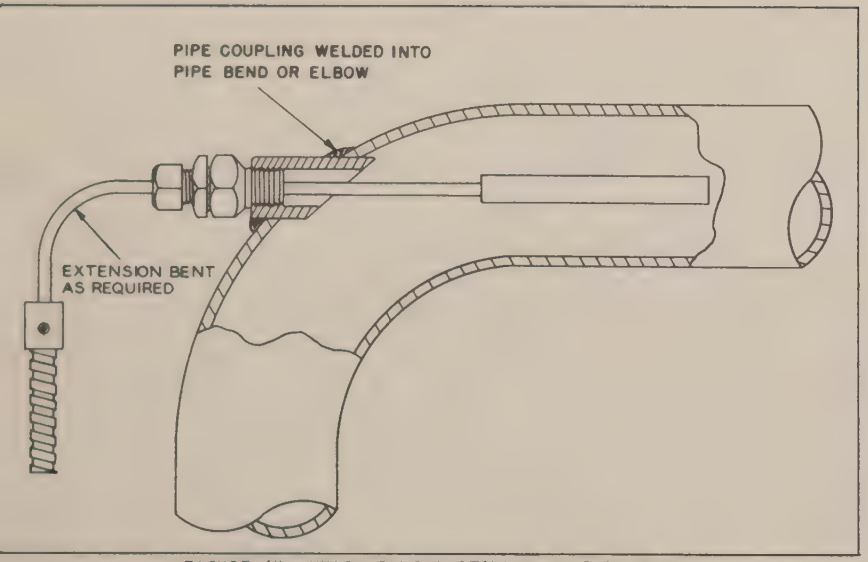


FIGURE 14 UNION BULB INSTALLED IN PIPE BEND

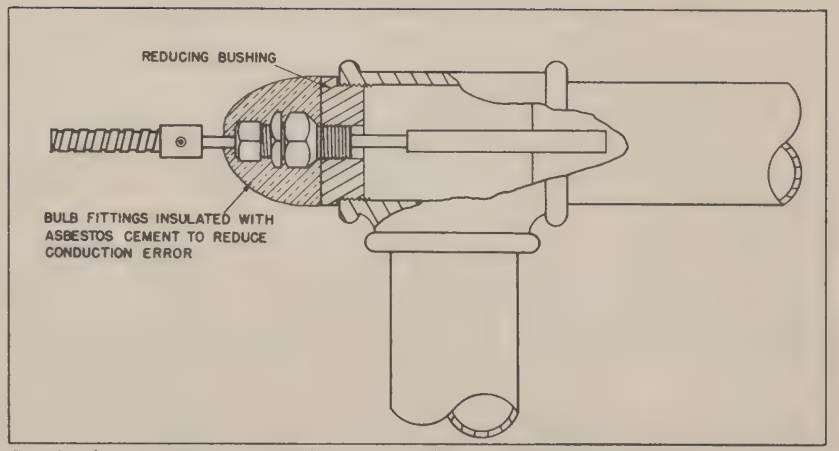


FIGURE 15 UNION BULB INSTALLED IN PIPE T, SHOWING INSULATION TO REDUCE CONDUCTION ERRORS

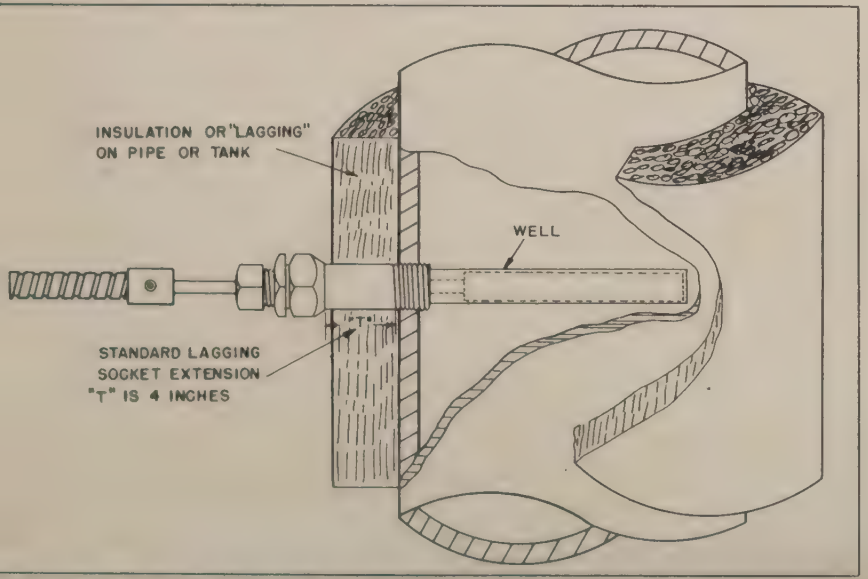


FIGURE 16 SOCKET WITH LAGGING EXTENSION INSTALLED THRU INSULATION OF PIPE

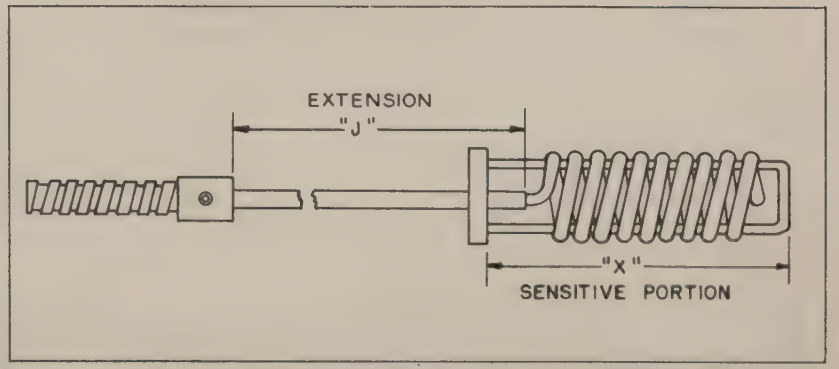


FIGURE 17 HIGH SENSITIVITY BULB FOR FAST RESPONSE

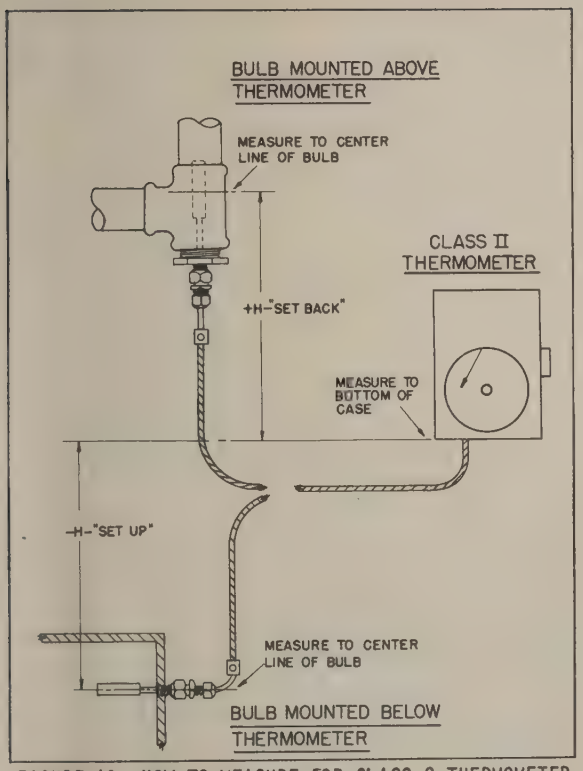

BULB MOUNTED ABOVE THERMOMETER
MEASURE TO CENTER LINE OF BULB
CLASS II THERMOMETER
+H-"SET BACK"
MEASURE TO BOTTOM OF CASE
-H-"SET UP"
MEASURE TO CENTER LINE OF BULB
BULB MOUNTED BELOW THERMOMETER

FIGURE 18 HOW TO MEASURE FOR CLASS 2 THERMOMETER BULB LEVEL CORRECTION

in bulb and case level is always measured from the center line of the bulb to the bottom of the case (see Figure 18). If possible, always order Class 2 thermometers with the bulb elevation specified so that level correction can be made in the factory.

How to Make Level Corrections in the Field. If it is necessary to make or change level corrections in the field, proceed as follows:

1. Comparison with a Test Thermometer. When the thermometer has been installed, place the thermometer bulb and an accurate test thermometer in a test bath located at the same level as that at which the bulb will be mounted. On instruments with non linear charts, turn point adjuster (10) until pen or pointer agrees with the test thermometer. On instruments with linear charts turn adjustment on temperature element until pen or pointer agrees with test thermometer. This method can also be used in laboratory calibration if the thermometer case is placed above or below the bulb during regular calibration procedure (see paragraph A, page 12, for calibration details).

2. Setting Pen by Correction Factor. If the above method is impractical, level correction can be made at any time while thermometer is installed or during calibration from data of Figures 19 and 20. These data apply only to instruments with non linear charts or scales. Elevation correction tables for instruments with linear charts may be had by writing to The Bristol Company, Waterbury, Connecticut. When writing, please specify model, serial and chart number of the instrument for which this information is desired.

For non linear charts proceed as follows:

Carefully measure difference in level between center line of bulb location and bottom of thermometer case (see Figure 18).

Select correction factor from proper column of Figure 19 or 20 corresponding to chart or scale range of thermometer concerned. Note that listed factors are for 10 feet difference in elevation.

Pen correction can now be calculated, using the following equation:

$$\text{Pen Correction (in inches)} = \frac{\text{Bulb Elevation (in feet)}}{10} \times \text{Factor from Figure 19 or 20}$$

Note: Pen correction will be plus if bulb is mounted below case. Pen correction will be minus if bulb is mounted above case.

Bring thermometer reading to any convenient steady value.

Using a finely graduated foot rule, set up or set back pen the required fraction of an inch by turning point adjustment (10).

Example: Bulb elevation 18 feet above bottom of case, chart number 22004, range 50 to 200°F. From column "bulb mounted above case - set back" (Figure 19) obtain 0.162 inches (exact correction). To obtain pen correction for 18 feet:

$$\text{Pen correction (inches)} = \frac{18}{10} \times 0.162" = 0.291" \text{ (approx. } \frac{19}{64}")$$

While thermometer is steady at any convenient temperature, say room temperature of 75°F, measure $\frac{19}{64}$" down range from 75° with an accurate steel rule. Turn

point adjuster (10) until pen reading has been set back by this $\frac{19}{64}$" amount.

G. Installation of Certain Special Bulbs

1. Atmospheric Temperatures. Thermometers for measuring weather temperatures should be equipped with extra sensitive bulbs (similar to Figure 17) in a weather house. The best location for a weather bulb is in the shade on the north side of a building (south side in southern hemisphere), at least 10 feet above ground and 2 feet out from wall, not opposite a window. For roof mounting, locate the bulb on a pole not less than 8 feet from the roof, preferably at a corner and in the full sweep of the wind from all directions. Do not mount bulb on chimneys, vents or near air shafts, sky lights, etc.

2. Averaging Bulbs. (See Figure 8.) Averaging bulbs are made with the maximum speed of response to change and due to their large dimensions can measure average temperature over a large area rather than at a point.

Averaging bulbs are, for convenience, shipped in a compact coil. **Do not pull out this coil,** but unwind it turn by turn as you would unwind wire from a spool. This will avoid twisting the bulb tubing, which might crack it. The bulb may be completely straightened out and mounted in oven, room or other process by clips or staples as with any other tubing. The bulb may be used partially coiled and supported by a rod as in Figure 8.

Caution: Never cut, break or flatten any part of averaging bulb tubing. Minimum radius of bend is 1 inch.

3. Electroplating Baths and Tanks. No part of bulb or tubing can touch any electrically conductive (metal) part of the tank or electrodes. All parts of the thermometer case and tubing must be electrically insulated from ground.

We recommend that bulb be installed on a wooden support in the tank and located between anodes and wall of tank.

Caution: Bulb or tubing must not be installed in a direct line between anode and cathode.

The thermometer case and tubing can be insulated by mounting on a wooden panel and supports.

Conduits and air control piping (if any) connected to the case must be insulated with plastic bushings.

PART III OPERATION

Filled system thermometers begin to operate as soon as the system is filled in the factory and operate continuously thereafter. For this reason no operating instructions are necessary for the thermometer system. Operation of the recording and controlling system (if any) is covered in separate instructions.

PART IV SERVICE

A. Checking and Calibrating

1. Testing for Friction. Be sure to eliminate all friction before attempting to recalibrate any thermometer. Under bad conditions of high humidity, corrosive fumes, gum forming vapors, dust laden air, etc., a possible reason for loss of calibration is corroded or dirty bearings in the thermometer system.

a. Overall test for Friction. This test should always be made before checking or calibrating.

Immerse bulb in test bath and allow pen or pointer to come to a final reading undisturbed. While watching pen or pointer closely, gently tap instrument case with a fist. If pen or pointer jumps to a new position, there must be friction somewhere.

b. Test for Element Shaft Friction. With fingers, gently move split hub (20) in and out. There should be a small amount of end play and the bearing should slide very freely on the shaft. If the bearing does not slide freely on the shaft take the bearing apart without disturbing length of lever (28) or adjustments (11), (25) or (26). To take bearing apart, loosen split hub setscrew (19), slip hub

off hollow bearing sleeve, remove 2 element mounting screws (27) and slip element together with hollow bearing off shaft. Clean bearing and shaft as per paragraph C, page 18.

In controlling thermometers check also for friction in all control links, levers, bearings, vanes, etc., which are moved by the thermometer element.

c. Pen Pressure. Considerable friction can result if the pen point bears too heavily on the chart. With fingers, bend pen arm until pen touches chart with just enough pressure to trace properly.

2. Cautions for Calibration or Checking.

Be sure thermometer case is exactly level.

Use a test thermometer with a range close to that of the thermometer being tested.

Use a recently tested test thermometer with an accuracy of 1% or better.

With recorders, make readings only from actual pen tracings quickly obtained by loosening the chart hub and turning chart slightly by hand.

3. Checking and Calibrating Procedure. Thermometers may be checked while installed or may be removed to the shop or instrument laboratory. It is best to calibrate while installed for the following reasons:

a. Saves time and handling of easily damaged tubing.

b. Automatically corrects for existing ambient temperatures along the tubing and at the case.

c. Automatically corrects Class 2 thermometers for difference in bulb and case levels.

There are two methods of checking the accuracy of filled system thermometers:

1st. Point Adjustment (also called zero adjustment). Thermometer is checked and adjusted at one point of its range only, which assures that it coincides with the standard thermometer at one temperature only.

2nd. Span Adjustment (also called range, scale length, etc., adjustment). Thermometer is checked and adjusted at two points or more of its range, which assures that it coincides with the standard thermometer at all temperatures thruout its range. This adjustment changes the span thru which the pen travels for a given change in temperature.

Step 1. Point Check and Calibration. Remove bulb from application. Remove socket or well (if any) from bulb. Run thermometer up and down scale 3 or 4 times before checking readings, especially if system has been out of service for some time, by immersing bulb alternately in cold and hot test baths.

Place an armored, glass-stem test thermometer alongside bulb so that the two bulbs are as close together as possible and then tie them together with string.

Immerse bulb and test thermometer in hot test bath. Be sure the entire sensitive portion and no more is covered.

Note: If bulb will be used with a portion of its extension (J), or a portion of its capillary tubing immersed in the measured medium, that same portion should be covered by the test bath. This procedure will correct for immersion errors. Note that glass stem test thermometers are calibrated in two ways, one for total immersion and the other for partial immersion, in which case they will have an immersion mark etched into the glass stem. Be sure that test thermometers are correctly immersed according to their calibration.

Stir test bath vigorously with a paddle for at least 3 minutes each time before taking readings. Never stir test bath with bulb itself. If possible, read test thermometer without removing it from the test bath and while continually stirring.

Quickly compare chart or scale reading with that of the test thermometer. If error is negligible and only a point check is desired, the checking procedure can end here.

If error is considerable, proceed as follows:

Turn point adjusting screw (10) until pen actually records the same temperature as the best thermometer. Recheck readings carefully. This completes the point calibration. Thermometer now coincides with test thermometer at this single point.

FIGURE 19. Correction Factors for Difference in Level between Bulb and Case. Applies only to Class 2 Recording Systems using non-linear charts. Note: Corrections listed are for a 10 foot difference. Use a proportional fraction of these corrections for level differences of more or less than 10 feet.

Chart Number	Chart Size in Inches	Temperature Range	Pen Corrections in Inches (for 10 ft.)			
			Bulb Mounted Above Case "Set Back"		Bulb Mounted Below Case "Set Up"	
			Exact Correction	Nearest 64th	Exact Correction	Nearest 64th
		FAHRENHEIT RANGES				
22007	12"	20-90	.2205	7/32	.2695	17/64
682	12"	23-95	.3465	11/32	.4235	27/64
28000	8"	0-100	.1131	7/64	.1309	1/8
3902	12"	60-110	.333	21/64	.407	13/32
633	8"	30-130	.1178	1/8	.1363	9/64
666	8"	30-130	.1178	1/8	.1363	9/64
1968	12"	60-140	.1692	11/64	.2067	13/64
660	8"	30-150	.0835	5/64	.0967	3/32
1934	12	30-165	.099	3/32	.121	1/8
22009	12"	30-165	.1143	7/64	.1397	9/64
618	12"	30-175	.0846	5/64	.1035	7/64
644	12"	30-175	.0846	5/64	.1035	7/64
1919	12"	30-175	.0846	5/64	.1035	7/64
676	12"	80-175	.1018	3/32	.1242	1/8
1922	12"	80-175	.1018	3/32	.1242	1/8
3801	12"	80-175	.1018	3/32	.1242	1/8
22012	12"	30-180	.099	3/32	.121	1/8
28008	8"	90-180	.0788	5/64	.0912	3/32
22001	12"	100-180	.1225	1/8	.1496	5/32
22008	12"	30-200	.1575	5/32	.1925	6/32
1944	8"	30-200	.1623	5/32	.188	6/32
22004	12"	50-200	.162	5/32	.198	13/64
22013	12"	50-200	.162	5/32	.198	13/64
22017	12"	80-200	.0792	5/64	.096	3/32
1917	8"	90-200	.102	7/64	.118	1/8
685	8"	100-200	.1095	7/64	.1268	1/8
657	12"	30-212	.1117	7/64	.1364	9/64
1932	12"	30-212	.1117	7/64	.1364	9/64
22015	12"	80-220	.0585	1/16	.0715	5/64
1913	8"	120-220	.863	5/64	.100	3/32
1920	8"	120-220	.0863	5/64	.100	3/32
637	8"	30-230	.0613	1/16	.071	5/64
661	8"	30-230	.0613	1/16	.071	5/64
1909	8"	30-230	.0613	1/16	.071	5/64
629	12"	30-230	.0917	3/32	.112	7/64
1904	12"	30-230	.0917	3/32	.112	7/64
1949	12"	30-230	.0917	3/32	.112	7/64
1975	12"	30-230	.0917	3/32	.112	7/64
22003	12"	50-230	.1062	7/64	.1298	1/8
1953	12"	70-250	.0747	5/64	.0914	3/32
1962	12"	70-250	.0747	5/64	.0914	3/32
3903	12"	70-250	.0747	5/64	.0914	3/32
1959	8"	80-250	.0492	3/64	.0569	1/16
.662	8"	30-270	.0882	3/32	.1020	7/64
.696	12"	30-270	.1323	1/16	.1618	5/32
1911	12"	30-270	.1323	1/8	.1618	5/32
634	8"	30-300	.0556	3/64	.0645	1/16
663	8"	30-300	.0556	3/64	.0645	1/16
686	8"	30-300	.0556	3/64	.0645	1/16
1946	12"	30-300	.0847	5/64	.1035	7/64
22010	12"	30-300	.055	3/64	.0671	1/16
22011	12"	30-300	.055	3/64	.0671	1/16
22008	12"	30-300	.055	3/64	.0671	1/16
22009	8"	100-300	.0370	1/32	.0408	3/64
28001	8"	200-300	.0516	3/64	.0569	1/16
1921	12"	200-300	.1020	7/64	.1242	1/8
28003	8"	220-310	.0486	3/64	.0537	3/64
1963	12"	140-320	.0675	1/16	.0825	5/64
1916	8"	200-320	.050	3/64	.058	1/16
1925	8"	200-320	.050	3/64	.058	1/16
664	8"	30-330	.0406	3/64	.0452	3/64
1991	8"	30-330	.0408	3/64	.0452	3/64

-continued-

FIGURE 19 CORRECTION FACTORS FOR DIFFERENCE IN LEVEL BETWEEN BULB & CASE

678	12"	30-330	.0576	1/16	.0705	5/64
1929	12"	30-330	.0576	1/16	.0705	5/64
1942	12"	30-330	.0576	1/16	.0705	5/64
1957	12"	150-340	.0505	3/64	.0616	1/16
675	8"	30-350	.0287	1/32	.0332	1/32
1951	8"	30-350	.0287	1/32	.0332	1/32
1945	12"	30-350	.0432	3/64	.0528	3/64
28002	8"	200-350	.0418	3/64	.0484	3/64
22019	12"	200-350	.0576	1/16	.0705	5/64
1918	12"	100-360	.0477	3/64	.0584	1/16
1988	12"	100-360	.0477	3/64	.0584	1/16
1956	12"	225-375	.036	1/32	.044	3/64
1914	8"	30-400	.0147	1/64	.0172	1/64
1996	8"	30-400	.0147	1/64	.0172	1/64
1912	12"	30-400	.0252	1/32	.0308	1/32
636	8"	30-415	.013	1/64	.015	1/64
28005	8"	250-420	.1320	1/8	.1525	5/32
22025	12"	200-450	.1378	9/64	.1684	11/64
28004	8"	250-450	.102	7/64	.118	1/8
671	8"	30-500	.0492	3/64	.057	1/16
687	12"	30-500	.0747	5/64	.0913	3/32
1901	12"	30-500	.0747	5/64	.0913	3/32
1940	8"	100-550	.034	1/32	.0387	1/32
22020	12"	200-550	.0585	1/16	.0715	5/64
22022	12"	100-600	.0388	1/32	.0473	3/64
			REAUMUR RANGES			
692	8"	0-63°R	.0557	1/16	.0644	1/16
631	12"	0-63	.0837	5/64	.1025	7/64
635	12"	0-63	.0837	5/64	.1025	7/64
22005	12"	20-70	.090	3/32	.110	7/64
615	12"	0-88	.0837	5/64	.1025	7/64
624	12"	0-88	.0837	5/64	.1025	7/64
22014	12"	20-105	.0712	5/64	.087	3/32
			CENTIGRADE RANGES			
643	8"	0-50°C	.137	9/64	.159	5/32
1905	8"	0-55°C	.114	7/64	.132	1/8
1979	12"	25-65	.162	5/32	.198	13/64
1903	8"	20-71	.0835	5/64	.0967	3/32
28006	8"	0-75	.077	5/64	.089	3/32
1908	8"	0-80	.0553	1/16	.0643	1/16
1955	12"	0-80	.0837	5/64	.1025	7/64
1986	12"	0-80	.0837	5/64	.1025	7/64
22028	12"	30-80	.118	1/8	.144	9/64
632	8"	0-100	.076	5/64	.088	3/32
683	8"	0-100	.076	5/64	.088	3/32
665	12"	0-100	.115	7/64	.141	9/64
695	12"	0-100	.115	7/64	.141	9/64
22000	12"	60-100	.0945	3/32	.1155	7/64
1994	12"	0-104	.0468	3/64	.0572	1/16
1999	12"	0-104	.0468	3/64	.0572	1/16
1906	8"	0-110	.0603	1/16	.0697	1/16
1907	8"	0-110	.0603	1/16	.0697	1/16
1936	12"	0-110	.0918	3/32	.112	7/64
28007	8"	0-110	.0324	1/32	.0376	1/32
22026	12"	40-110	.123	1/8	.1485	9/64
1902	12"	0-130	.142	9/64	.174	11/64
674	12"	0-130	.142	9/64	.174	11/64
22016	12"	0-130	.0675	1/16	.0825	5/64
22027	12"	0-130	.0675	1/16	.0825	5/64
1939	8"	0-132	.0388	1/32	.045	3/64
1933	12"	25-145	.0945	3/32	.1155	7/64
630	8"	0-150	.0547	3/64	.0633	1/16
1971	8"	0-150	.0547	3/64	.0633	1/16
22024	12"	40-150	.0513	3/64	.0627	1/16
22018	12"	40-155	.0468	3/64	.0572	1/16
1943	12"	60-160	.0675	1/16	.0825	5/64
679	12"	0-165	.0576	1/16	.0705	5/64
1923	12"	0-165	.0576	1/16	.0705	5/64
1973	12"	30-165	.0576	1/16	.0705	5/64
1964	8"	50-165	.0388	1/32	.045	3/64
1948	8"	50-175	.0315	1/32	.0365	1/32
1937	12"	50-175	.0468	3/64	.0572	1/16
641	8"	0-185	.026	1/32	.030	1/32
1927	12"	50-195	.0306	1/32	.0374	1/32
677	8"	0-200	.0176	1/64	.0202	1/64
1960	8"	0-200	.0176	1/64	.0202	1/64
1952	12"	50-250	.0848	1/64	.1045	1/64

FIGURE 19 - CONTINUED -

Figure 20. 8" Segment Scale Indicating Class 2 Thermometer Correction Factors for Difference in Level Between Bulb & Case.
Note: Corrections listed are for a **10 feet difference.** Use a proportional fraction of these corrections for level differences of more or less than 10 feet.

Scale Number	Temperature Range Degrees	Pointer Corrections in inches (for 10 feet)			
		Bulb Mounted above case "set back"		Bulb Mounted below case "set up"	
		Exact Correction	Nearest 64th	Exact Correction	Nearest 64th
5300	50-130F	.276	9/32	.320	21/64
5301	60-160F	.167	11/64	.193	3/16
5302	80-190F	.109	7/64	.127	1/8
5303	100-230F	.067	1/16	.077	5/64
5304	100-270F	.086	3/32	.100	3/32
5305	150-320F	.054	3/64	.061	1/16
5306	250-350F	.081	5/64	.094	3/32
5307	200-370F	.054	3/64	.061	1/16
5308	240-420F	.253	1/4	.293	19/64
5309	300-470F	.148	9/64	.172	11/64
5310	300-500F	.115	7/64	.133	9/64
5311	40-110C	.067	1/16	.077	5/64

If it is desired to have the thermometer read correctly thru its whole range, proceed as below.

Mechanical Alignment. This step should be necessary only if the link length adjustment (11) or adjustments of lever (9) or hub (20) have been disturbed. Mechanical alignment adjustment places all links and levers in correct geometrical relation so as to minimize angularity errors.

Place bulb in test bath at a temperature to hold pen or pointer at about mid chart or scale.

Loosen hub screw (19) and two link screws (11). Center the point adjuster (10). While manually holding pen or pointer at mid scale, adjust length of link (13) so that imaginary line "A-A" connecting the center line of element shaft and link bearing (24) is parallel to lever (9). While holding this parallelism tighten screws (11) and hub screw (19) firmly.

Step 2. Span Check and Calibration. It will be necessary to remove the chart plate and chart to reach the span adjustment.

Screwing span adjustment nut (26) back and forth changes the effective length of threaded lever (28). Increasing the lever length increases the span thru which the pen travels for a given temperature change. Decreasing the lever length decreases the span thru which the pen travels for a given temperature change.

Proceed as follows: Carefully perform point calibration as in Step 1 above. Immerse bulb and test thermometer in a cold test bath. Stir and compare readings as directed above.

If span is too long (thermometer reads low), loosen span lock screw (25) and reduce span by turning span adjustment nut (26) slightly toward shaft end of threaded lever. If span is too short (thermometer reads high), turn nut toward outer end of threaded lever.

Recheck in a hot bath and adjust with point adjustment on pen arm. Recheck in cold bath and adjust span if necessary.

Alternately repeat point and span adjustments until thermometer is exactly correct in both hot and cold baths. Retighten span lock screw (25) firmly. Thermometer should then coincide with test thermometer at all values of its range.

Note: On controlling thermometers with either electric or air control, the controller set-point indexes must always be adjusted after pen or pointer adjustment is changed. For details of calibration of set-point indexes, see separate instructions furnished covering the controlling system.

To avoid inconvenience of repeated removal and replacement of the recording chart and chart plate between each test reading, prepare a cut away chart from thermometer being calibrated as per Fig-

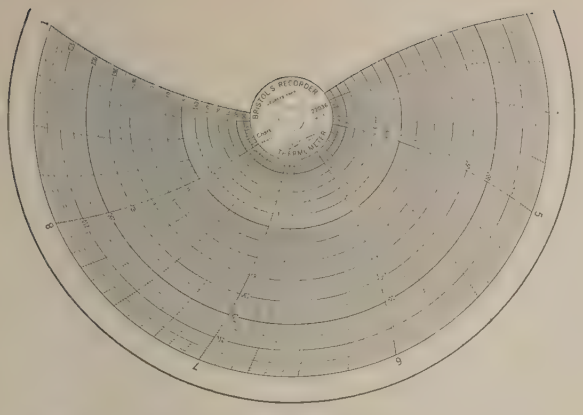


FIGURE 21 CUTAWAY CHART FOR USE IN CALIBRATION

ure 21. Paste cut away chart on stiff cardboard for support. During calibration remove chart plate and use this cut away chart held by chart hub.

4. Calibrating Temperatures. If only a point check and calibration is made, it is obviously wise to select a test bath temperature close to the working range of the thermometer.

If a span calibration is to be made, select "cold" and "hot" test bath temperatures at approximately 20% and 80% of the full range of the thermometer being tested.

B. Replaceable Thermometer Systems

All Bristol filled type thermometer systems are so made that entire temperature systems can be exchanged or replaced in the field without disturbing its calibration. New factory calibrated thermometer systems can be ordered from Bristol at any time. Factory made replacement systems are calibrated and tested in a standard recording thermometer, then removed without disturbing the calibration. The systems are then packed and shipped ready for easy installation in the field.

1. Changing Ranges. An important feature of Bristol thermometers is that thermometer systems of any range or any class can be interchanged without drilling or extra parts. Another feature is that a thermometer can be changed to a gauge by replacing the thermometer system with a pressure gauge system.

2. Standby Thermometer Systems. Users having a quantity of Bristol thermometers will find it advantageous to stock one or two calibrated thermometer systems of each range used, for quick replacement in case of damage to or failure of a system. Standby thermometer systems should be ordered with tubing long enough for any existing installation and equipped with a Bristol universal bulb for ready adaptation to almost any bulb installation.

3. How to Remove Thermometer Systems. Systems to be exchanged, repaired or replaced should be removed as follows:

Remove bulb from the process. Dismount tubing, coil and tie it, being careful not to cut, twist or kink it.

Remove case fitting (15), which holds tubing, from the split connecting plate. **Do not** allow weight of the coil of tubing to hang by the delicate capillary (17).

Disconnect lower end of link (13) from span adjuster (25) by lifting and swinging aside tab (24). **Do not** loosen screw (25) or disconnect top bearing of link (13) from lever (9).

Note: There are several bearing holes in pen shaft lever (9). All holes but one are painted black. Your thermometer was factory calibrated using the unpainted hole. **Use no other.**

Dismount bracket (18) by removing 2 screws (23) which hold it to the back of the case.

Remove entire thermometer system as a unit including element, element mounting, span adjuster, tubing, case connection fitting and bulb.

4. How to Install Replacement Thermometer Systems. Carefully unpack replacement system. **Do not** disturb any of its adjustments.

Install element and tubing in the reverse order to instructions given in paragraph 3 above.

When completely installed except for the bulb, perform a point check at working temperature as instructed in Step 1 on page 13. If span adjuster and connecting link have not been disturbed, the thermometer should be in perfect calibration.

Note: When thermometer systems from 8" and 12" size instruments are interchanged, a complete recalibration is required due to the difference in pen arm radii and pen weight.

5. How to Order Replacement Thermometer Systems. Order replacements from the nearest Bristol Branch Office, giving the serial number and chart number of your thermometer as listed on the name plate inside the door. If ordering a system not exactly like your existing one, be sure to specify the new range and new chart number desired, or new bulb number, union or socket thread size and length of tubing. If changing range, don't forget to order a stock of the charts.

C. Lubrication and Cleaning

Never lubricate any bearing in a thermometer measuring system. If bearings become gummy or dirty, clean with a solvent such as carbon tetrachloride applied with a small soft brush. If bearings become badly corroded, polish gently with crocus cloth. **Never** Use a file or emery.

For lubrication of chart drives see recording system instructions.

D. Repairs, Correspondence and Shipping

Send all correspondence and orders to the nearest Bristol Branch Office.

Send all parts and thermometers for repair or exchange only to Branch or Main Factories, not to Branch Offices.

Be sure to state model and serial numbers in all orders, correspondence and shipments.

Identity your shipments fully, including exact return address, your order number, etc.

See last page of instruction book for list of addresses of Bristol Field Organization.

The Bristol Company
Waterbury 20, Conn.

Printed in U.S.A.

INSTRUCTION NO. Y19800

(Issue No. 5 of 6/54)

INSTALLATION AND SERVICE OF BRISTOL'S STANDARD MODEL 500 AND 530 CASES

TABLE OF CONTENTS

	Page
PART I GENERAL	2
A. Description	2
B. Accessories	2
PART II INSTALLATION	2
A. Location	2
B. Mounting the Case	2
1. Surface Mounting	2
2. Flush Mounting	2
3. Flush Mounting (Special)	2
PART III CASE CONNECTIONS	3
A. General	3
B. Standard Connection Sequence	3
C. Color Coding for Multiple-pen Recorders	3
D. Air-control Connections	3
E. Case-connection Fittings	3
PART IV CASE CHANGES AND SERVICE	3
A. General	3
B. Changing from Back to Bottom Connected	3
C. Changing from Bottom to Back Connected	4
D. Service and Repair	4

THE BRISTOL COMPANY WATERBURY 20, CONN.

PART I GENERAL

A. Description

Bristol's Model 500 and 530 Cases include many valuable features, such as uniformity of design and function, interchangeable mounting accessories (surface or flush), universal connection plates, etc. Case sizes are based on the nominal chart or dial dimensions. The Model 500 case is called the 12" case, and the Model 530 is called the 8" case.

B. Accessories

All Bristol Instruments are provided with mounting accessories for surface or flush mounting as specified on the sales order. In addition, other accessories, such as fixtures, extra parts, etc., may be supplied. These are always packed with the instrument and are itemized on the packing list. Do not throw away the packing until everything has been located and identified.

PART II INSTALLATION

A. Location of the Instrument

Select a location as free as possible from dust, dirt, corrosive fumes, vibration and extremes of temperature. Although Bristol instruments will operate satisfactorily under unfavorable conditions, the life and effectiveness of the instrument can be prolonged by using a recommended location.

B. Mounting the Case

Always mount the case vertically and level. Use a spirit level or plumb bob to check this. See Instructions Y19809 for mounting dimensions.

1. Surface Mounting. Surface mounting refers to any vertical surface, such as a wall, bracket or any other structure upon which the instrument may be fastened. Drill three 5/16" holes to take 1/4" bolts or wood screws according to mounting-dimensions drawing.

Attach the three brackets to the instrument in the surface-mounting position as shown in Figure 1 and fasten it securely to the surface.

2. Flush Mounting. Flush mounting means inserting the entire instrument into an opening so that only its door protrudes beyond the surface of the panel, wall or other mounting place. Cut out the hole in panel according to mounting-dimensions drawing. The maximum thickness of the panel cannot exceed 1 7/8" except for the bottom-connected 4-pen recorder with electric chart drive; this panel thickness cannot exceed 5/8".

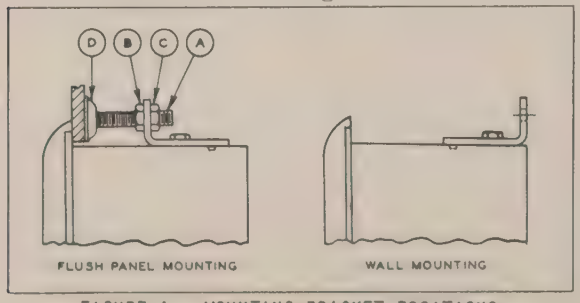


FIGURE 1. MOUNTING BRACKET POSITIONS

Allow horizontal space between instruments as specified in the mounting dimensions to give door clearance. Vertical space between instruments should not be less than 5" when they are flush mounted, back connected. Allow more between bottom-connected instruments.

After the hole is cut in the panel, remove the mounting bracket from the top of the case, unscrew all case connections (except thermometer tubing and filled pressure seals - see paragraph 3 below), and insert the back of the instrument thru the hole, bottom first. On thicker panels it may be necessary to remove all three mounting brackets. Have someone hold the instrument in front while the brackets are being replaced. After mounting brackets are replaced, loosen nuts B and C and screw A. Force screw A against reinforcing disc D. Turn nut B until snug against mounting bracket. Tighten screw A Lock in place by tightening nut C with a wrench. It is not necessary to tighten nut B with a wrench.

3. Flush Mounting of Bottom-connected Thermometers and Pressure Gauges with inseparable pressure seals. Case connections for these instruments cannot be removed, and extra clearance in panel cutouts must be allowed. See notes on mounting-dimensions drawing, Y19809. Gauges and thermometers in Model 530 (8") case may need wooden shims between the case bottom and the panel if the panel is over 1/2" thick. Be careful not to bend severely or pull on thermometer and seal tubing.

PART III CASE CONNECTIONS

A. General

The Model 500 and 530 cases are provided with a universal connection plate (Figure 2) which can be used for bottom or back connections and can be changed at any time.

Before making any connections to your instrument, check the voltage and frequency specified on the instrument nameplate and study the wiring diagram provided (wiring diagrams are generally not provided when the only electrical connections are for a chart drive).

B. Standard Connection Sequence

Measuring elements, chart drive, etc., are always connected in a standard sequence in Model 500 and 530 cases for gauges and thermometers. Separate diagrams are always furnished with gauges and thermometers, showing the standard connection sequence.

C. Color Coding for Multiple-pen Recorders

Each measuring system in Bristol's multiple-pen recorders is identified by a standard color code. The color for each system is listed on the instrument nameplate inside the case door. This color is painted on each pen arm, set-point index, set-point knob, case connection and also on thermometer bulbs (if used). The color of the recording ink also corresponds to the color code.

D. Air-control Connections

Case connections for supply and output air for pneumatic controllers are not made thru the universal connection plate, but at separate connections shown in the mounting dimensions for such instruments.

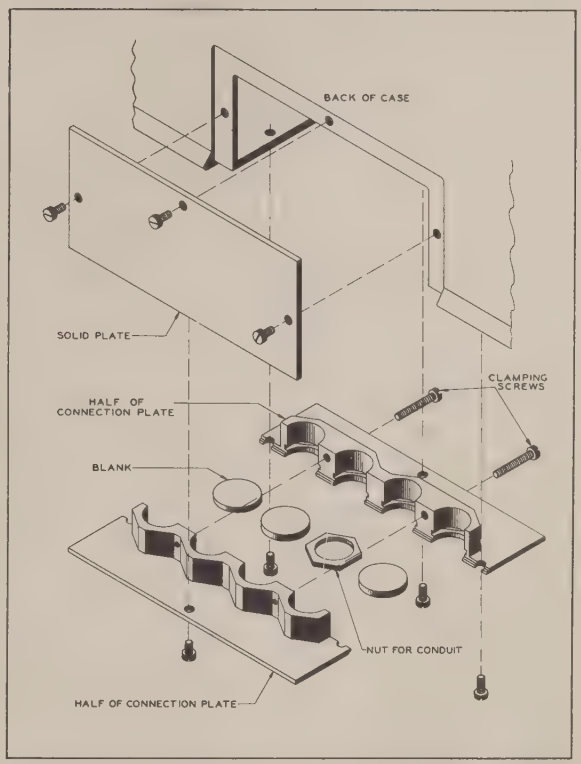


FIGURE 2. EXPLODED VIEW OF UNIVERSAL CONNECTION PLATE

E. Case-connection Fittings

A number of different fittings are available for standard conduit, pipe, electrical wiring, tubing, etc. A blank may be supplied to seal any unused connection holes.

PART IV CASE CHANGES AND SERVICE

A. General

Case-connection changes can be made without extra parts, using only a screwdriver. If different fittings are required (see paragraph D above), they may be ordered from Parts List Y19807.

All changes are made from the outside of the instrument case.

B. Changing from Back to Bottom Connected

Uncouple all inflexible connections to the connection plate, such as pipe, conduit, etc. (Do not attempt to remove thermometer tubing or other sealed systems.) Remove the solid plate from the bottom of the case by taking out the four screws holding it (a surface-mounted case will have to be removed from the surface upon which it is mounted). Then remove the three screws holding the connection plate, being careful to hold the plate so that it will not damage the tubing or other connections which cannot be removed. Do not unclamp the connection plate.

Now move the connection plate from the back to the bottom position, being careful not to damage the flexible connections. Fasten the connection plate into the bottom position and the solid plate into the back position. If you have removed a surface-mounted case, replace it on the surface. Attach any couplings, conduit, etc., that might have been removed while making the change.

C. Changing from Bottom to Back Connected

The same procedure outlined in paragraph B above is followed when changing from bottom to back connected.

D. Service and Repair

Parts List Y19807 gives a complete list of all the parts of the Model 500 and 530 cases. Order replacement and spare parts from this list.

The Bristol Company
Waterbury 20, Connecticut., U.S.A.

Printed in U.S.A.

INSTRUCTION NO. Y19802

(Issue No. 4 of 6/53)

OPERATION AND SERVICE

OF ROUND-CHART RECORDING SYSTEM

NOTE: This instruction covers only the recording system. See separate instructions covering the measuring system, control system, etc.

A. Unpacking

1. Standard Recorder Accessories. Every Bristol round-chart recorder is supplied with one of each of the following items:

box of 100 charts, range and chart number as ordered.

1-ounce bottle of ink with dropper. Multiple-pen instruments get a 1-ounce bottle of different color ink for each pen supplied.

pen cleaner wire (.005" diameter) with instructions in envelope

brass chart-drive key (spring drive only)

FIGURE 1. QUICKSET CHART HUB - OPEN

2. Shipping Devices

a. Remove and discard the paper packing support under pen arm.

b. Remove from under chart hub the circular instruction on the operation of Quickset chart hub. Read this instruction carefully.

B. How to Change Charts

1. Push pen lifter down in order to hold pens and pointers away from chart.

2. Tip up Quickset chart hub, as shown in Figure 1, and slip off the old chart.

3. If instrument has a spring chart drive, wind chart drive by inserting brass key thru hole in chart plate.

4. Slip new chart over chart hub, under slot (18) in chart plate and under time index (3). Turn chart by hand until time index points to correct time. **Note:** Pens on multiple-pen recorders, in order

FIGURE 2. QUICKSET CHART HUB - CLOSED

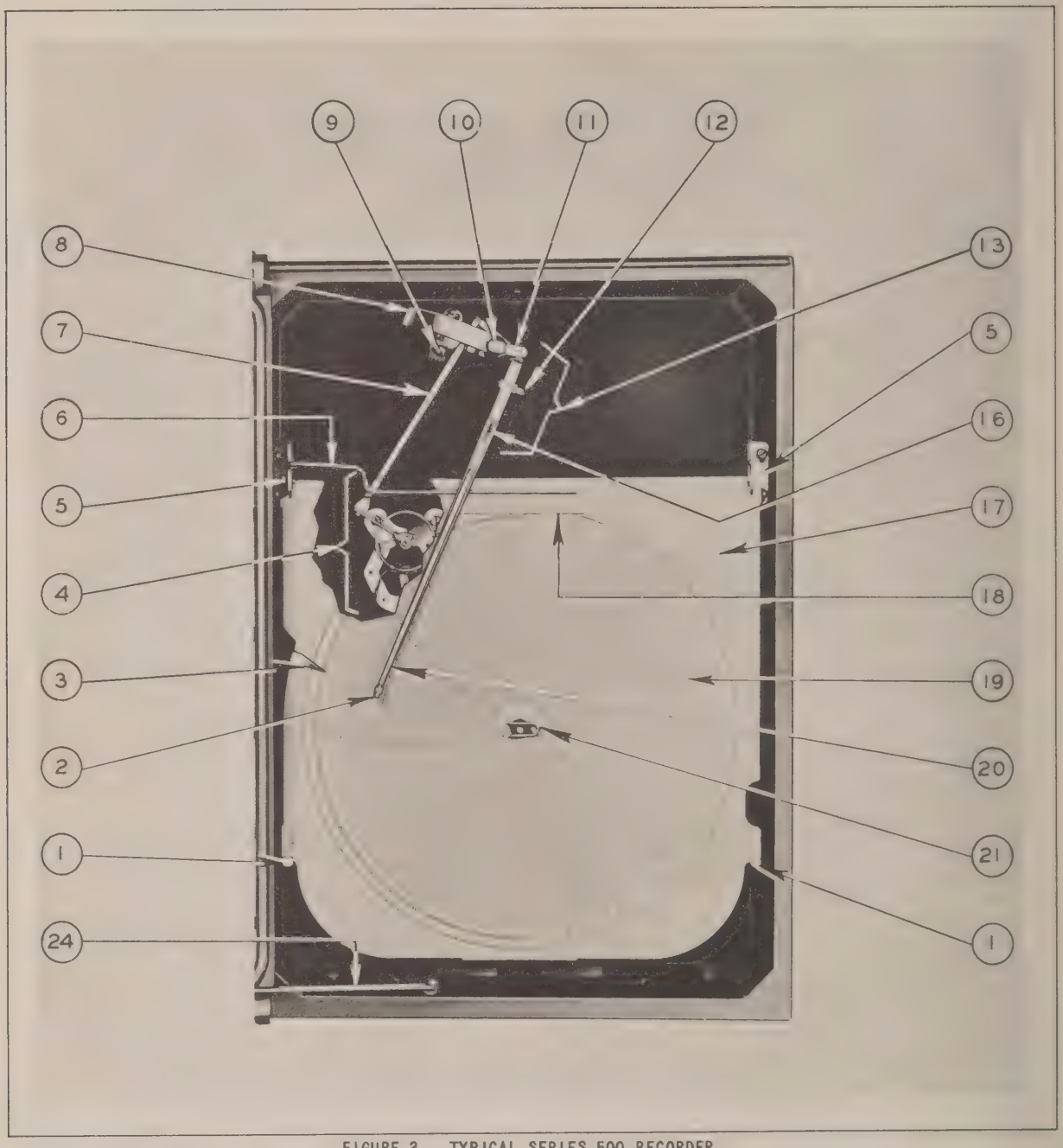


FIGURE 3. TYPICAL SERIES 500 RECORDER

to pass each other, cannot all swing on the same time arc of the chart. Therefore, the time index on such recorders is adjusted to indicate the time of the red pen, which is the only pen that follows the arc of the chart. Allowance must be made for this time difference between pens when reading charts made by multiple-pen instruments.

5. Turn chart hub down as shown in Figure 2 and push firmly on its curved end in order to hold chart. **Note:** Dairy recorder chart hubs are made with a pin which perforates the chart to prevent its being rotated by hand once it has been clamped down. Be sure to turn chart of dairy recorders to correct time at time index before pushing chart down over pin.

6. Add ink to pen or pens per paragraph C.2, page 3.

7. Lower pen or pens gently onto chart by pushing pen lifter upward.

Code To All Photos

1. Spring catch for chart plate
2. Pen
3. Time index
4. Measuring element
5. Chart plate bracket
6. Pen lifter
7. Measuring element connecting link
8. Universal pen mounting
9. Screws holding above
10. Cap screws holding tabs
11. Bearing tab
12. Micro adjustment
13. Base end of pen
14. Pen shaft lever
15. Pen shaft
16. Screws holding pen arm
17. Chart plate
18. Slot to hold top of chart
19. Recording chart
20. Pen arm
21. Quickset chart hub
23. Universal connection plate
24. Door stop
30. Speed regulator of spring chart drive
31. Start knob
32. Screws holding spring drive in case
33. Winding arbor
34. Screws holding drive cover
35. Gear change speed indicator
36. Gear change knob
37. Spring drive cover
40. Laminated core
41. Name plate of telechron motor
42. Gear train
43. Electric drive mounting plate
44. Electrical connection wires
45. Screws holding drive in case
46. Electric drive terminals
50. Shipping strap of complete motor unit
51. Motor shaft
52. Screws holding shipping strap
53. Rotor unit
54. Soldering lugs
55. Field coil
56. Location of "top" marking & rotor data
57. Rotor pinion gear
58. Screw holding motor into gear case
59. Copper shading coils

C. Pens

1. Types

a. Single-pen Recorders. Single-pen recorders are supplied with either a "V" pen or a fountain pen. Fountain pens and V pens are not interchangeable. A special fine-bore fountain pen is sometimes used for recording variables which change widely and often. If the ink record of your recorder tends to overlap and run, a fine-bore fountain pen should be obtained to replace the standard-bore fountain pen. For records of very long duration, standard-bore and fine-bore pens are available with large barrels holding 6 drops of ink. All standard- and fine-bore, 3- and 6-drop fountain pens are interchangeable.

b. Multiple-pen Recorders. Multiple-pen recorders are supplied with flattened fountain pens with capillary tips of different lengths so that they can pass each other on the chart. The pen nearest the chart is called the 1st pen, the next pen is called the 2nd pen, etc. Be careful not to bend pens (or pen arms) of multiple-pen recorders as they must pass each other without touching. Multiple-record instruments are supplied with a maximum of 2 pens on the 8" size case and 4 pens on the 12" size case.

All pens should be replaced as soon as the tip is worn, broken or corroded.

See parts list of recording accessories for complete listing of pens.

2. How to Ink and Start Pens. Pens, as supplied, usually will hold more than enough ink for one complete chart revolution. However, it is wise to refill pens every time the chart is changed.

a. V Pen. Fill V pens 2/3 full, using dropper from ink bottle supplied. If pen fails to trace when lowered on chart, touch its tip with a moistened finger.

b. Fountain Pen. Fill fountain pens to the top, using dropper from ink bottle. Standard pens take about 3 drops of ink. If pen fails to trace when lowered on chart, try touching tip of capillary tube with a moistened finger. If pen still fails to trace, pull pen off pen arm and squeeze between thumb and finger (as per Figure 4), then dip end of capillary tube in a drop of ink and release pressure of fingers. Replace pen by pushing pen all the way up on forked end of pen arm.

Use the 1-ounce bottle and pen filler furnished for re-inking pens. Buy recording ink in the economical larger size bottles and refill the 1-ounce bottles. See parts list of recording accessories for complete listing of all inks, bottles, and pen fillers.

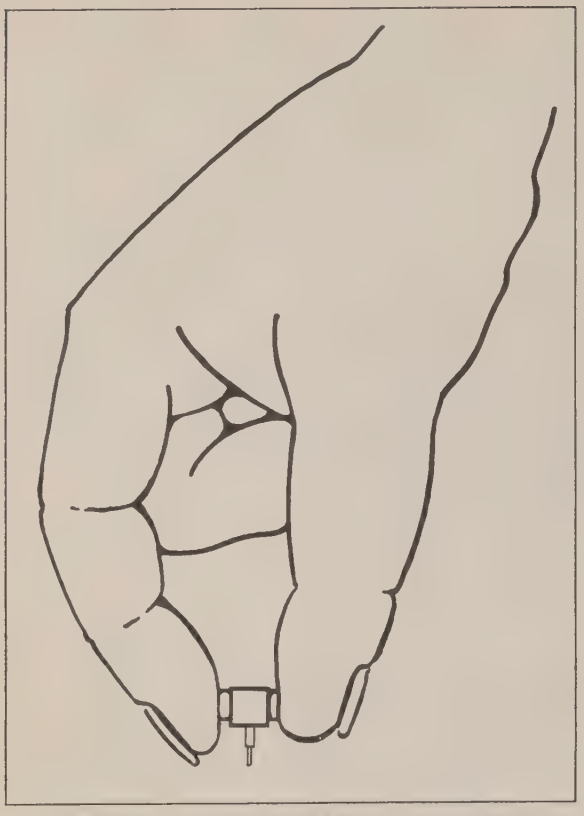


FIGURE 4. STARTING FOUNTAIN PEN TO INKING

3. How to Clean Pens. Pens should be cleaned periodically to forestall trouble because only a clean pen can trace a clean record.

To clean either a V pen or a fountain pen, loosen screw (16) holding pen arm and pull pen arm and pen off of base end (13). Wash pen in alcohol, ammonia or very hot water (if necessary, boil pen in water for a few minutes).

Clean out capillary tip of fountain pen by inserting pen cleaner wire supplied.

Replace pen arm and pen, being sure to push prongs of pen arm up under rivets on base end until it snaps into place. Retighten locking screw.

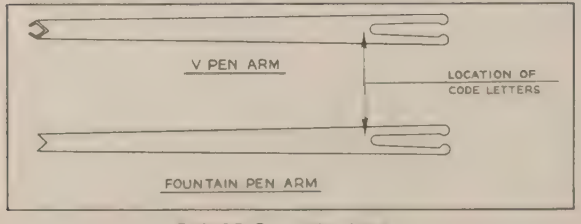


FIGURE 5. PEN ARMS

D. Pen Arms

Pen arms for V pens and for fountain pens (see Figure 5) are not interchangeable. Pen arms for 1st, 2nd, 3rd and 4th pens of multiple-pen recorders are of different lengths and, therefore, are not interchangeable.

All Bristol pen arms are identified by code letters stamped into their upper ends. Be sure to specify these code letters from your old pen arm when ordering replacements.

Do not bend pen arms. If the effective length of the pen arms is altered, the pen will not swing along the time arc on the chart and, therefore, will not record the measured variable correctly. If pen arms of multiple-pen recorders are bent, they will not pass each other freely.

E. Removing Chart Plate

The chart plate of Series 500 recorders can be removed without tools in the following manner:

Raise pen or pens by pushing down on pen lifter. Tilt up chart hub and remove chart. With thumbs of both hands, depress simultaneously 2 clips (Item 1 of Figure 3) and pull bottom of chart plate out and

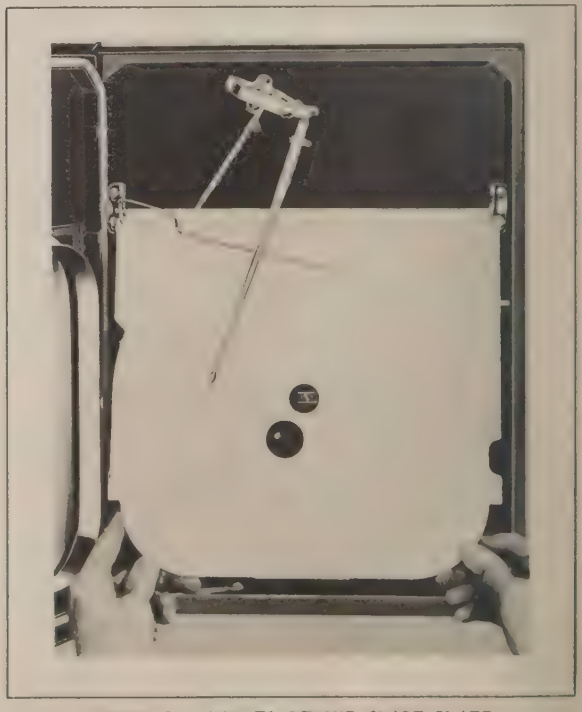


FIGURE 6. HOW TO REMOVE CHART PLATE

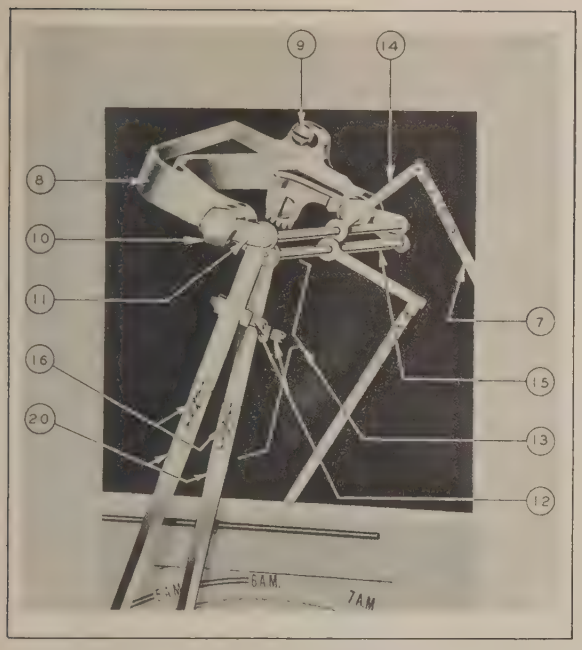


FIGURE 7. UNIVERSAL PEN MOUNTING - 2 PEN

down (see Figure 6). Chart plate may be replaced in the reverse order to above.

F. Pen Mounting and Base Ends

All Series 500 recorders are equipped with the same style universal pen mounting. Mounting parts can be easily replaced or mounting can be quickly converted to accommodate any multiple combination.

On most recorders the pen shaft (Item 15, Figure 7) can be removed by gently lifting top bearing tab (11) and slipping shaft out. Pen mounting can be disassembled by removing 2 screws (10).

Micro adjustment (12) is spring loaded to eliminate all lost motion. Its knob is both knurled and slotted for easy adjustment with fingers or a screwdriver. See measuring-system instructions for this adjustment.

A complete listing of all pen-arm mountings and parts is given in parts list for recording accessories.

G. Ink

1. Standard Color Code. Colors of ink will be furnished according to the following standards, unless ordered otherwise.

a. Single-pen recorders-red

b. Two-pen recorders

1st pen-red (pen nearest chart)
2nd pen-blue

c. Three-pen recorders

1st pen-red (pen nearest chart)
2nd pen-blue
3rd pen-black

d. Four-pen recorders

1st pen-purple (pen nearest chart)
2nd pen-red
3rd pen-blue
4th pen-black

The color of ink to be used in each pen of multiple-record instruments is painted on its pen arm or base end.

2. Standard Ink. Standard Bristol recorder ink will perform well at internal case temperatures from -10°F to +110°F (-23°C to +43°C).

3. Low-temperature Ink. Bristol low-temperature ink is recommended for case temperatures from -65°F to +32°F (-54°C to 0°C). It will flow evenly and will not freeze at these temperatures.

4. High-temperature Ink. Bristol high-temperature ink is recommended for case temperatures from +100°F to +400°F (+38°C to +204°C). This ink will not dry in pens or boil away when used between these temperatures.

5. Quick-Drying Ink. This type of ink is recommended with high speed charts (15-, 30- and 60-minute rotation) because it dries quickly and permits charts to be removed immediately when finished without smearing the record.

Quick-drying ink is also recommended where high humidity conditions exist.

Note: Use only Bristol recorder inks. Ordinary inks dry too fast, clogging and corroding pens. A complete listing of Bristol Company inks is given in parts list for recording accessories.

H. Chart Drives

All Bristol chart drives for round-chart recorders have identical mountings and are, therefore, interchangeable. Thus, chart rotation time or voltage and frequency used can be quickly changed. Spring and electric drives are also interchangeably mounted.

1. Service Chart Drives. All Bristol Branch and Main Factories carry stocks of carefully rebuilt, fully guaranteed spring and electric chart drives which will be exchanged for the same specification defective drive for a nominal charge. In

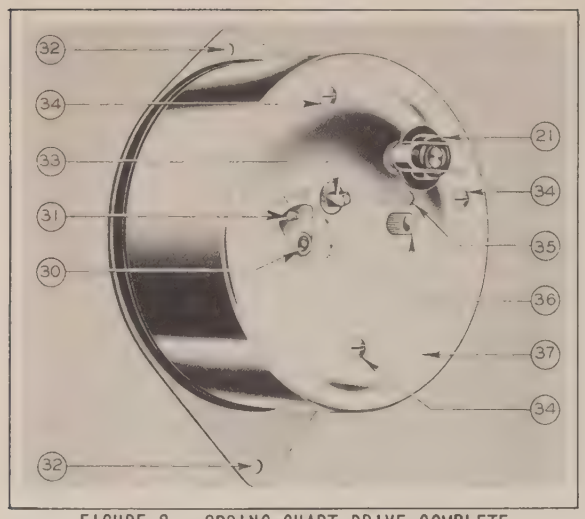


FIGURE 8. SPRING CHART DRIVE COMPLETE

order to positively identify correct speed, gear ratio, voltage and frequency, etc., we must receive your old chart drive before shipping the replacement service drive.

Instrument users having several Bristol recorders would do well to keep one or two, two-speed spring service chart drives in stock as universal standby replacements.

2. Spring Chart Drives

a. How to Wind. With chart removed, insert brass key thru hole in chart plate and wind arbor clockwise as far as it will turn. Wind all spring chart drives once each week, except the 2 and 8 hour and the 24 and 96 hour two-speed chart drives which must be wound each day.

b. How to Start. If chart drive does not start by itself when wound, push start lever (Item 31, Figure 8) quickly to the right and then release.

c. Adjusting Speed. If chart revolves too fast or too slow, the speed of chart drive should be adjusted by turning adjusting screw (Item 30, Figure 8) slightly in the direction required. Turning the screw clockwise makes the drive go faster and turning the screw counterclockwise makes the drive go slower.

d. Two-speed Drives. Some spring chart drives are equipped with a gear changer to produce two different chart rotations, for example: 24 hour and 7 day. To change from one rotation to the other, turn knob (Item 36, Figure 8) in a direction to show the desired rotation time at opening (Item 35) in chart-drive cover.

e. Lubrication. Under normal conditions a spring chart drive should be cleaned and oiled about once a year. Where severe conditions exist, more frequent cleaning and oiling will be required. Only an experienced clock worker with proper equipment should be allowed to completely service a chart drive. Unless such are available, we recommend that chart drives be returned to The Bristol Company for exchange. (See "Service Chart Drives" paragraph H.1.)

For servicing spring chart drives, proceed as follows:

1st. Remove 3 mounting screws (32) and take complete chart drive out of instrument case.

2nd. Remove chart hub by loosening its setscrew with a small screwdriver.

3rd. Remove 3 screws (34) and pull off cover (37).

4th. Disassemble movement and soak all parts **except** main spring assembly in benzine. Shake off excess benzine and allow all parts to dry thoroughly.

5th. Oil the main spring liberally with Bristol clock oil, Part No. 60822.

6th. Reassemble movement completely.

7th. Apply a small amount of Bristol clock oil to each bearing with a toothpick. For internal case temperatures above 32°F (0°C) use Bristol Part No. 60822 oil. For case temperatures below 32°F (0°C) use Bristol Part No. 60821 oil.

8th. Replace chart-drive cover, being careful to correctly position start lever and gear-shift knob. Replace chart hub and remount drive in recorder case.

3. Electric Chart Drives.

Electric chart drives are powered by a 2-watt, self-starting synchronous motor which depends for its timing on the frequency of the alternating-current supply. Therefore, the frequency must be exactly as listed on name plate to obtain accurate chart timing. Where frequency is unregulated, we recommend use of spring chart drives.

Most recorders require power-supply wires to be connected directly to the terminal block on the chart drive.

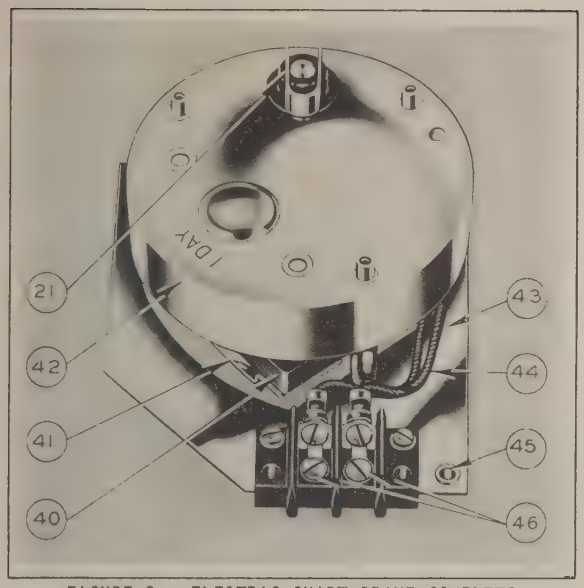


FIGURE 9. ELECTRIC CHART DRIVE COMPLETE

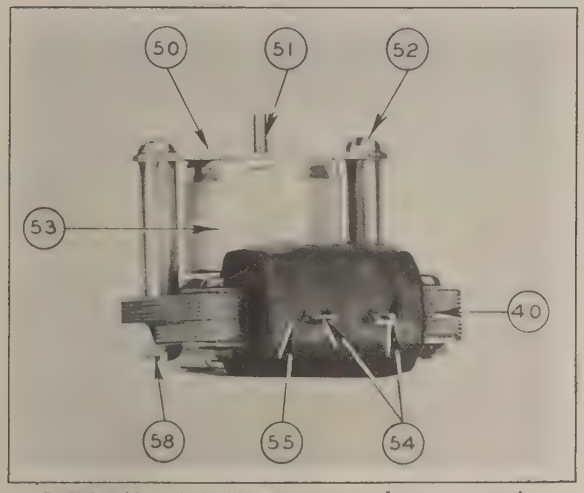


FIGURE 10. REPLACEMENT MOTOR (LESS PINION)

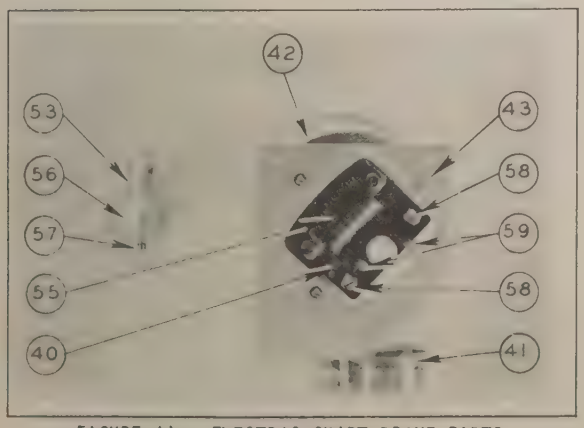


FIGURE 11. ELECTRIC CHART DRIVE PARTS

Caution: Before connecting power supply to chart drive, be sure to check on chart-drive base plate for correct voltage and frequency.

A supply-voltage variation of plus or minus 10% or less will not affect accuracy of timing.

There is no starting knob or speed regulator on electric chart drives. Electric chart drives will restart automatically after power failure, but the lost time must be made up by manually advancing the chart to correct time.

The Bristol Company can supply a reactor for installation in the chart-drive supply circuit to permit a 120-volt chart drive to operate on a 240-volt supply. This is especially convenient for portable test recorders, which can thus be operated from either 120- or 240-volt supply lines.

a. Replacement of Parts. Electric-chart-drive parts are supplied in three arrangements:

1. Complete drive as in Figure 9.
2. Motor unit complete as in Figure 10.
3. Rotor and pinion only shown in Figure 11. (Items 53, 56 & 57).

See parts list for complete chart-drive listing. As a rule either the motor complete or the rotor only need be replaced because of wear. Motor complete is furnished with shipping plate and screws to hold it together during shipment. These should be removed and discarded when motor unit is put into use.

By changing motor units and/or rotor units, any electric chart drive can be rebuilt to produce any standard combination of voltage and frequency. In ordering replacement parts, specify all data on the motor name plate. In ordering rotors, specify all data stamped on its barrel. Direction of rotation can be reversed by turning over the laminated magnet and field coil assembly (Items 40 and 55).

b. Disassembly of Chart Drive. Turn off power supply and disconnect leads from terminals. Unscrew 3 screws (45) and remove complete chart drive from

instrument case. Turn chart drive upside down and remove 2 screws (58) which permits rotor and motor to be removed from gear train. Note carefully position of the 2 copper shading coils (59) on laminated core before disassembly.

Replace rotor, motor, etc., as required and reassemble. Be sure to replace laminated magnet with copper shading coils (59) in same position as before. The direction of rotation of the rotor and consequently that of the chart can be reversed by turning magnet over and installing it with shading coils in the reverse position.

Note that the rotor has the word "top" stamped into edge of barrel. In assembling, turn rotor so "top" will be uppermost when chart drive is mounted in the instrument case to assure proper lubrication.

Replace chart drive in case and reconnect to power supply.

c. Lubrication. Rotor unit never requires lubrication. After 2 or 3 years use, the gear train only (motor and rotor removed) should be cleaned with benzine, allowed to dry and then oiled with Bristol clock oil Part No. 60822 (for temperatures above 32°F) or Bristol Part No. 60821 (for temperatures below 32°F).

4. Combination Electric and Spring Chart Drives. When starting up for the first time or after prolonged shutdown, be sure to wind the spring in duplex chart drives. The spring drive will operate for an aggregate of 24 hours at one winding. When the spring is run down, a red signal (or indicator) will appear in a hole in the outer casing of the chart drive.

The combination electric and spring chart drive is wired in the same manner as the standard electric drive referred to in paragraph 3, page 6. If the electricity should fail, the spring drive unit starts immediately. The chart drive is fast acting in the change-over from electric to emergency operation and vice versa. A hairpin clutch and magnets hold the balance wheel at peak tension while the electric drive is in operation.

J. Repairs, Correspondence and Shipping

Address all correspondence and orders to the nearest Branch Office.

Ship all parts for repair or exchange only to Bristol Branch or Main Factory, never to Branch Offices. Identify all shipments fully, including your exact return address and repair order number. Be sure to state model and serial number of instrument in all orders and correspondence.

Addresses and phone numbers of Bristol Field Organization are listed on the last page of all instruction books.

The Bristol Company
Waterbury 20, Conn., U.S.A.

Printed in U.S.A.

BRISTOL'S SERIES 500 AND 534 ELECTRONIC FREE-VANE CONTROLLERS

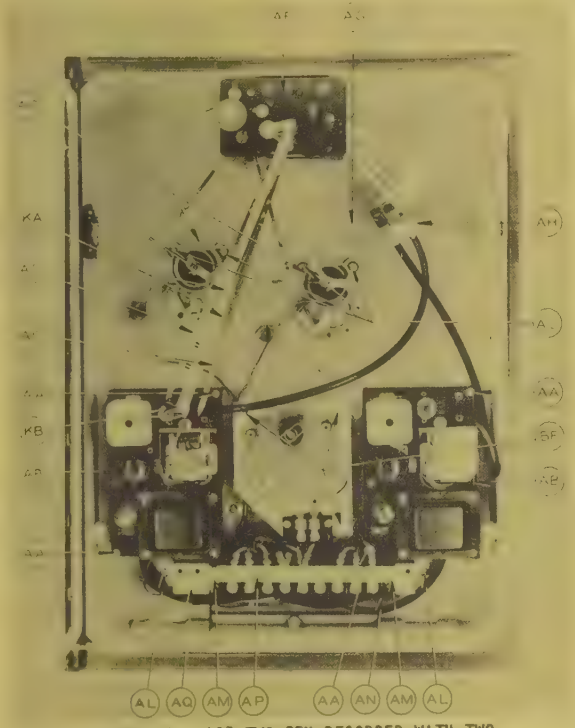


FIGURE 1. 12" TWO PEN RECORDER WITH TWO CONTROL UNITS

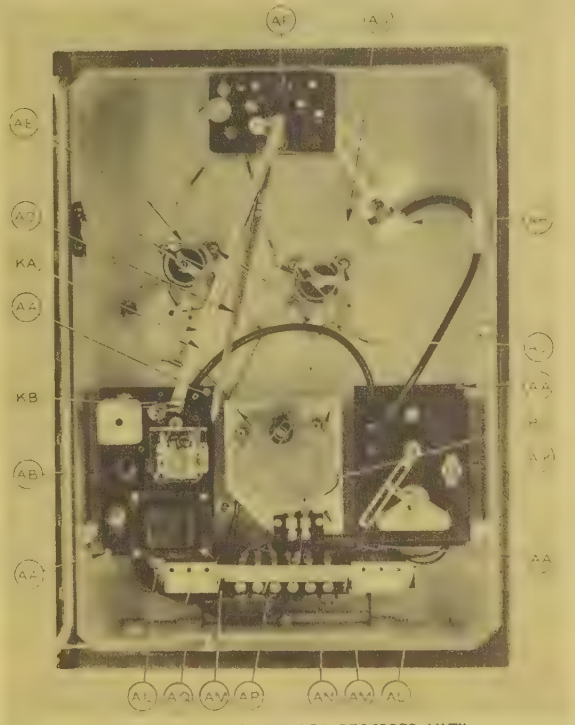


FIGURE 2. 12" TWO PEN RECORDER WITH PROPORTIONAL INPUT UNIT

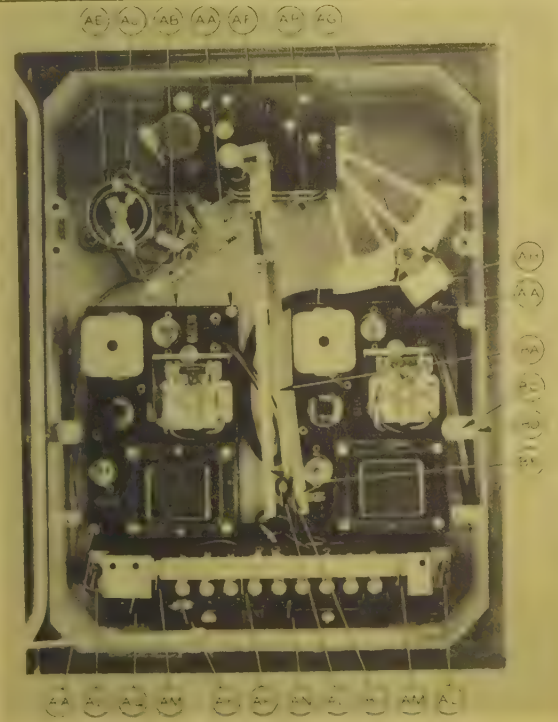


FIGURE 3. 8" TWO UNIT INDICATOR WITH DIAL PLATES REMOVED

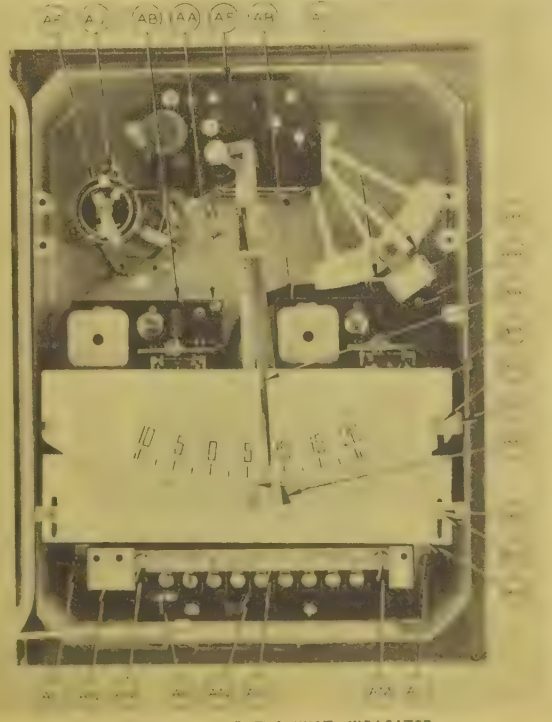


FIGURE 4. 8" TWO UNIT INDICATOR

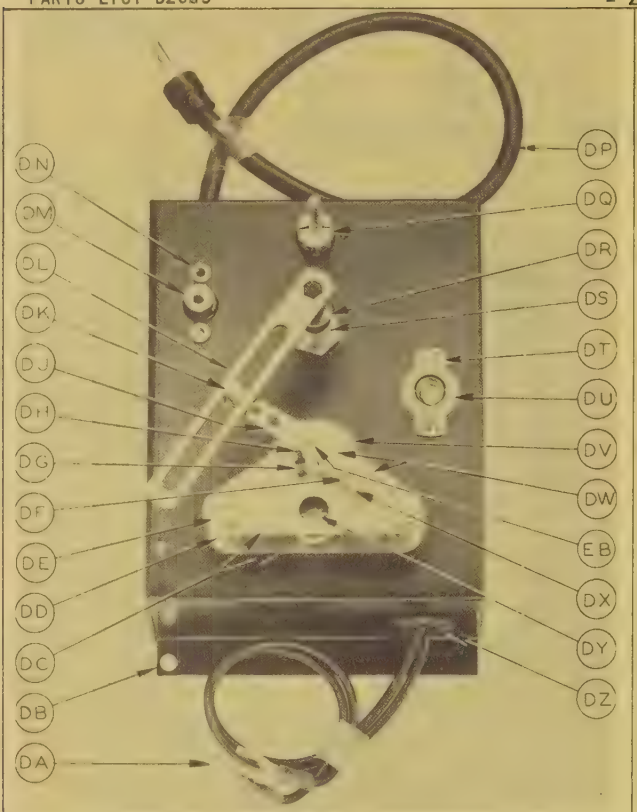


FIGURE 5. INPUT UNIT - FRONT VIEW

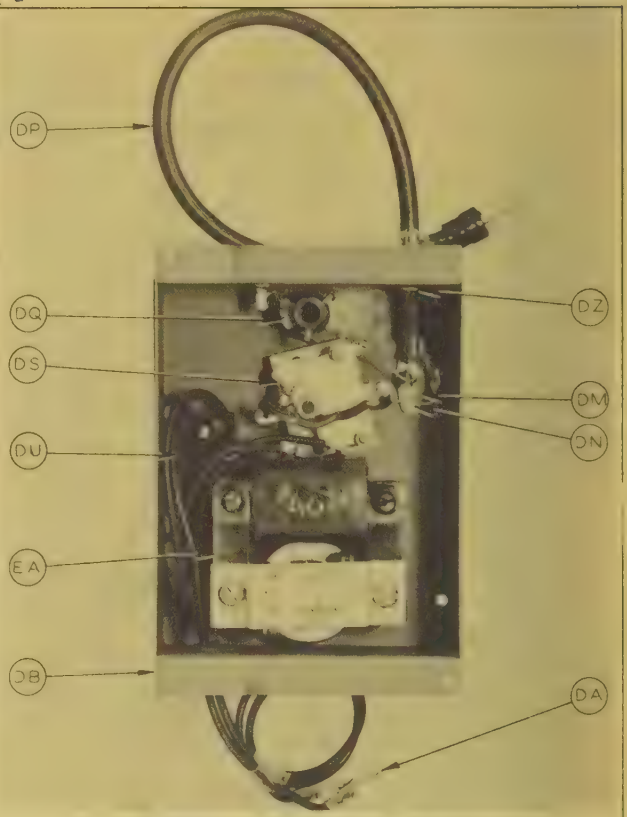


FIGURE 6. INPUT UNIT - BACK VIEW

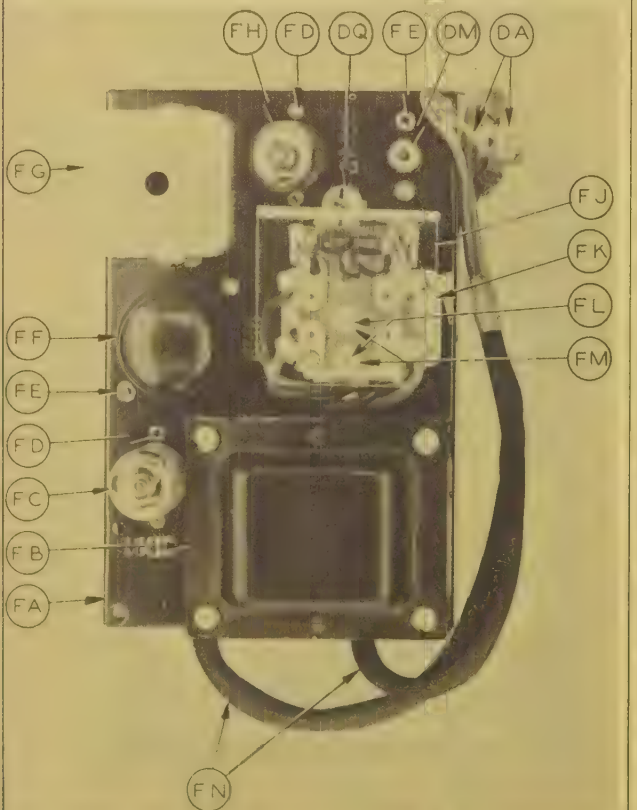


FIGURE 7. CONTROL UNIT - FRONT VIEW

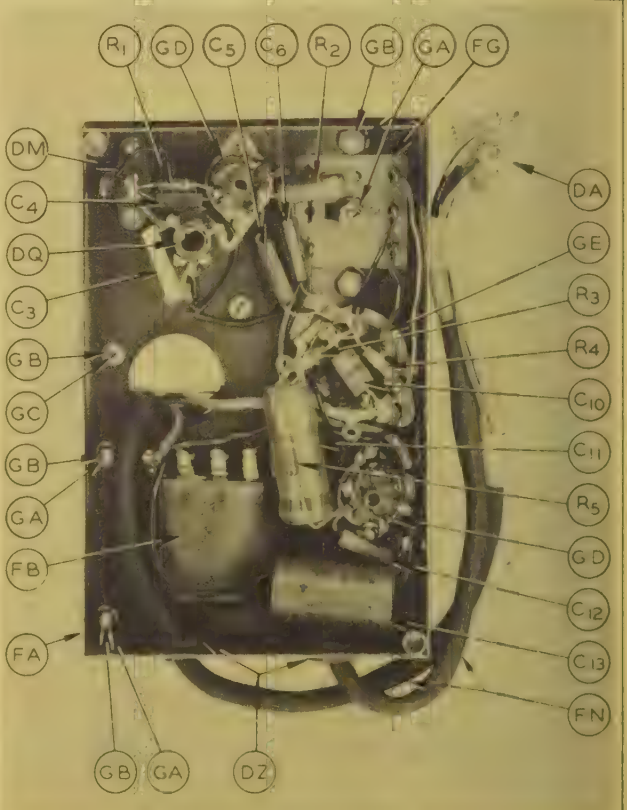


FIGURE 8. CONTROL UNIT - BACK VIEW

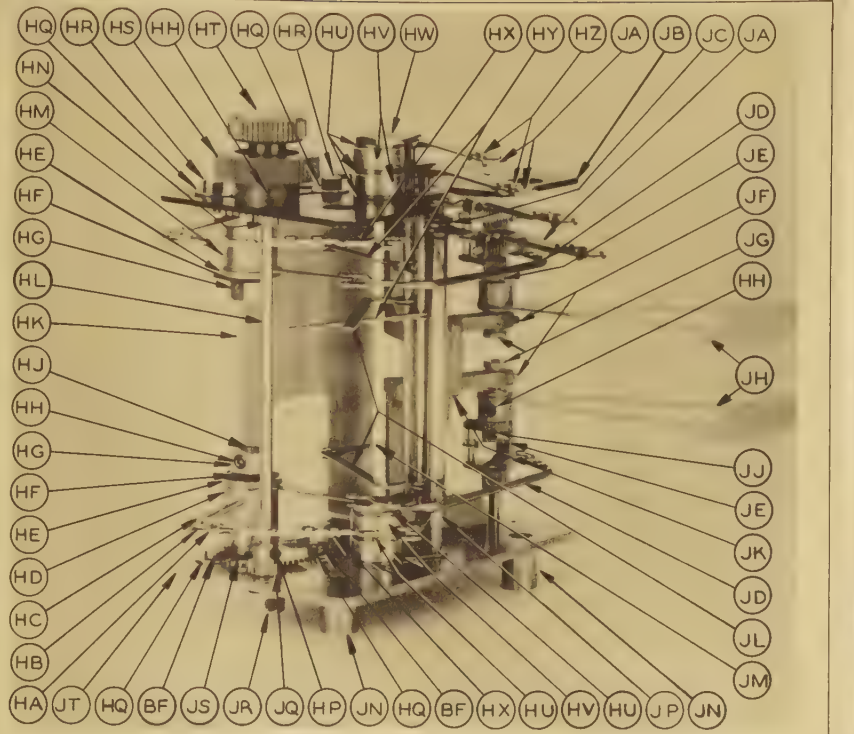


FIGURE 9. DIFFERENTIAL PEN MOUNTING

CAPACITORS AND RESISTORS FOR CONTROL UNIT

ITEM	DESCRIPTION	PART NO.
C_3	Capacitor - 55 mmfd - 500 volts d-c	91431
C_4	" - 39 mmfd - 500 volts d-c	90562
C_5	" - 750 mmfd - 500 volts d-c	90560
C_6	" - 750 mmfd - 500 volts d-c	90560
C_{10}	" - 2 mmfd - 500 volts d-c	90563
C_{11}	" - .05 mfd - 400 volts d-c	77701
C_{12}	" - 750 mmfd - 500 volts d-c	90560
C_{13}	" - 4 mfd - 250 volts d-c	90561
R_1	Resistor - 15,000 ohm - 1/2 watt	90556
R_2	" - 47,000 ohm - 1 watt	83977
R_3	" - 150,000 ohm - 1/2 watt	87019
R_4	" - 270,000 ohm - 1/2 watt	90557
R_5	" - 2.2 megohn - 1/2 watt	89087

BE SURE TO STATE MODEL AND SERIAL NUMBERS OF INSTRUMENT WHEN ORDERING PARTS

ITEM	DESCRIPTION	PART NO.
AA	8-32 x 1½" Fillister-head screw for control unit	90670
	8-32 x 1/4" Fillister-head screw for input unit	40066
Not Shown	Washer under screw for recorder	92965
AB	Electronic control unit complete (for breakdown of parts see Figures 7 and 8):	
	For 120 or 240 volts, 50-60 cycles	90578
	For 120 or 240 volts, 25 cycles	90579
AC	Low set-point index	90653
AD	High set-point index	90652
	Single set-point index	90652
AE	Measuring element:	
	Thermometer system including measuring element, bulb, mounting sleeve, and tubing must be replaced or repaired as a unit. For repairs, system must be returned to The Bristol Company. In either case, give model, serial and chart numbers of instrument.	
	Pressure system. For replacement of pressure system including measuring element, tubing, and connection mounting, give model, serial, and chart numbers of instrument.	
AF	Differential pen mounting complete (for breakdown of parts see Figure 9):	
	For 8" single-control-unit indicator	90533
	For 8" double-control-unit indicator	90549
	For 12" single-control-unit 1-pen recorder	90550
	For 12" single-control-unit 2-pen recorder	91196
	For 12" double-control-unit 1-pen recorder	90544
	For 12" double-control-unit 2-pen recorder	90547
Not Shown	10-32 x 3/4" Fillister-head screw for mounting Item AF	66545
AG	Stop bracket mounted to left of control coil	90648
	Stop bracket mounted to right of control coil	90647
Not Shown	4-48 x 1/4" Fillister-head screw for mounting Item AG	61247
AH	Control coil and mounting complete - not including stop bracket:	
	For single-control-unit instrument	90693
	For double-control-unit recorder	90665
	For double-control-unit 8" indicator (specify with cover 92240)	90665
Not Shown	10-32 x 1/4" Fillister-head screw for mounting Item AH	66537
AJ	10-32 x 3/8" Fillister-head screw for mounting measuring element	66539
AK	Proportional-input unit complete (for breakdown of parts see Figures 5 and 6):	
	For 60-second rotation, 50 or 60 cycles	91400
	For 60-second rotation, 25 cycles	91417
	For 30-second rotation, 50 or 60 cycles	91420
	For 30-second rotation, 25 cycles	91421
	For 15-second rotation, 50 or 60 cycles	91424
	For 15-second rotation, 25 cycles	91425
AL	10-32 x 1/4" Fillister-head screw	66537
Not Shown	Mounting post for indicator	90656
AM	8-32 x 1" Self-tapping screw	86722
Not Shown	Spacer	72166
AN	Terminal block (6 terminals)	87238
	Terminal block (9 terminals)	85288
AP	Terminal marking strip (LCHI23)	90696
	Terminal marking strip (LCHI23LCH or LCNH..123)	90654
AQ	Terminal-block mounting bracket	76253
BA	Indicating pointer	90697
BB	Scale Plate - Order by model and serial numbers of instrument	
BC	10-32 x 1/4" Special-head screw	39425
BD	Bracket	86751
Not Shown	6-40 x 1/4" Fillister-head screw for bracket Item BD	39770
BE	Control index - high	90698
	Control index - low	90699
	Control index - single	90804
BF	6-40 x 1/4" Fillister-head screw	39770
BG	Washer	6965
BH	Dial plate	86724
BJ	Mounting bracket	90807
DA	Terminal	83882
DB	Chassis	91413
DC	Bearing plate	91402
DD	Post	91403
DE	10-32 Shoulder screw	89048
DF	Split hub (.125" shaft)	65957
DG	1-72 x 3/32" Hex-head screw	67694
DH	Washer	91409
Not Shown	Collar	42956
Not Shown	6-40 x 1/8" Flat-point setscrew	82403
DJ	Arm	91406

BE SURE TO STATE MODEL AND SERIAL NUMBERS OF INSTRUMENT WHEN ORDERING PARTS

ITEM	DESCRIPTION	PART NO.
DK	Stud	91412
DL	Slotted arm	91407
DM	Socket	91980
DN	Eyelet	65100
DP	Cable	91408
DQ	Oscillator coil	90569
DR	Collar	93848
	2-64 x 1/16" Spline Cup-point setscrew	.....
DS	Variable capacitor complete including Item DR but not:	91401
	Lockwasher between capacitor and chassis	79844
DT	Switch plate	63786
DU	Switch including connecting wires	88365
DV	Change gear (driven) including setscrews Item HH:	
	48 Teeth	45319
	40 Teeth	47693
	30 Teeth	67856
DW	1-72 x 1/4" Flat-head screw	22680
Not Shown	Spacer	91405
DX	Eyelet	25571
Not Shown	Leaf spring	91410
DY	Change gear (driving) including setscrews Item HH:	
	12 Teeth	53490
	20 Teeth	47696
	30 Teeth	67856
DZ	Grommet	79767
Not Shown	Snap ring between grommet and chassis	72403
EA	Telechron motor - 120 volt, 50 or 60 cycle	45183
	Telechron motor - 120 volt, 25 cycle	45185
EB	Shaft	91404
FA	Chassis	90552
FB	Power transformer for 120-240 volt, 50-60 cycle	90576
	Power transformer for 120-240 volt, 25 cycle	90577
FC	2D21 Tube	90555
FD	Eyelet	92360
FE	Eyelet	92359
FF	6H6 Tube	90553
FG	Discriminator transformer	90573
FH	6AU6 Tube	90554
FJ	Relay protection plate	91521
FK	Relay	90570
FL	4-36 x 3/16" Fillister-head screw	91383
FM	Lockwasher	45692
FN	Insulating tubing	86252
GA	6-32 Hex nut	92923
GB	#6 Lockwasher	33982
GC	6-32 x 5/16" Fillister-head screw	63384
GD	Miniature socket	87029
GE	Octal socket	71708
HA	0-80 x 3/32" Fillister-head screw	31342
HB	Tab	83713
HC	4-48 Knurled nut	83702
HD	Lower-segment assembly complete for two-control-unit instrument including:	.....
	Items HE-HH, JS and Lower segment complete including Items HA-HC	90540
HE	Washer	90520
HF	Spider washer	61812
HG	6-40 Friction nut	90524
HH	6-40 x 1/8" Bristo flat-point setscrew	82403
HJ	Friction stud	90521
HK	Bracket	90501
Not Shown	6-40 x 3/16" Fillister-head screw for bracket Item HK	18339
HL	Shaft for two-control-unit instrument	90536
	Shaft for single-control-unit instrument	90525
HM	Upper-segment assembly complete including:	.....
	Items HE-HH, JS and Upper segment complete including Items HA-HC	90518
HN	Pinion for two-control-unit instrument	90537
	Pinion for single-control-unit instrument	90526
HP	4-48 x 1/8" Bristo flat-point setscrew	.....
Not Shown	Washer between plate and knob for single-control-unit instrument	90527
HQ	Stop blank	90523
Not Shown	6-40 Hex nut for stop	20903
HR	6-40 x 3/16" Fillister-head screw	18339

BE SURE TO STATE MODEL AND SERIAL NUMBERS OF INSTRUMENT WHEN ORDERING PARTS

ITEM	DESCRIPTION	PART NO.
HS	Knob for two-control-unit instrument	91430
HT	Knob not including:	85701
	6-40 x 1/8" Bristo flat-point setscrew	82403
	6-40 x 3/16" Bristo flat-point setscrew	82404
HU	Top tab for single-pen recorder only	84272
	Top tab for all other instruments	84271
	Second tab	84272
	Third tab	84272
HV	Spacer	84172
HW	Hex-head screw for two-pen recorder	92492
	Hex-head screw for all other instruments	84170
HX	Adjustable link	90522
	0-80 x .078" Fillister-head screw for adjustable link	71465
HY	Straight lever arm	84110
HZ	1-72 x 3/32" Special-head screw	82591
JA	Base end and shaft complete (includes Item HZ):	
	Top - for two-pen one-control-unit recorder	84270
	Top - for all other instruments	90809
	Second - for indicator	90531
	Second - for single-pen recorder	90532
	Second - for two-pen single-control unit recorder	90534
	Second - for two-pen two-control-unit recorder	90809
	Third - for two-pen recorder	90532
	Third - for two-control-unit indicator	90551
	Third - for single-pen two-control-unit recorder	90543
	Fourth - for two-pen two-control-unit recorder	90543
JB	Top plate	90502
JC	Washer for two-control-unit instrument	23212
JD	Special link	90514
JE	Differential complete for indicator (includes screw Item JJ)	91119
	Differential complete for recorder (includes screw Item JJ)	91118
JF	2-64 x 3/16" Setscrew	23748
JG	Adjustable pivot bearing	90526
JH	Vane complete	90504
JJ	4-48 x 1/8" Cup-point setscrew	.....
JK	Bearing mounting	90512
Not Shown	6-40 x 3/16" Fillister-head screws for mounting Item JK	18339
JL	Offset lever arm	83734
JM	Fixed link	87761
JN	Foot	90503
JP	Friction sleeve for two-control-unit instruments	90539
JQ	Pinion for two-control-unit instrument	90526
JR	Hub for two-control-unit instrument (does not include screw Item HH)	65045
JS	Friction washer	90519
JT	Bottom mounting plate	90500
KA, KB	Pens and Pen Arms:	
	For Single-Pen Recorder	
	Fountain-pen arm (marked FG)	90650
	V-pen arm (marked FE)	83728
	Fountain pen	32914
	V pen	42648
	For Two-Pen Recorder	
	Pen arm nearer chart (marked FG)	90650
	Pen arm farther from chart (marked FH)	90651
	Pen nearer chart	32914
	Pen farther from chart	32915

THE BRISTOL COMPANY
WATERBURY 20, CONN., U. S. A.

PARTS LIST
Issue No. 2 of 6/50

T8005

PARTS LIST FOR CONVERTIBLE THERMOMETER BULB FITTINGS

BE SURE TO STATE MODEL & SERIAL NUMBER OF INSTRUMENT WHEN ORDERING PARTS

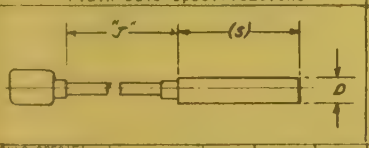
COMPLETE UNIONS AND SOCKETS

HOW TO ORDER UNIONS & SOCKETS

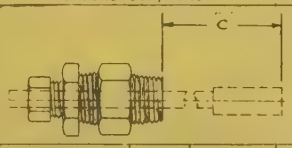
1st. Select specification of bulb you have (as listed on your thermometer name plate) from Column I.
2nd. Follow to the right along horizontal line column II listing complete union or column III listing complete socket.
3rd. Order complete union by part no. as listed in Column II.
4th. Order complete socket by part no and length "C" as listed in Column III.

Notes:
1. The bulb itself cannot be purchased separately, but only as part of a complete thermometer system.
2. Union and socket parts must be large enough to slip over sensitive portion "S" of bulb. Therefore, always go from bulb specification number horizontally or down in table to union or socket number.
3. Class I sensitive bulb length "S" varies with range so cannot be listed. However "S" length will be listed as last number of bulb specification on your thermometer's nameplate.
4. Minimum socket length "C" should be ordered long enough to accommodate sensitive portion "S" plus "J" immersion of 3 inches, if possible, and never less than 1 inch, to minimize conductivity errors. See "Thermometer Measuring System" instructions for explanation.

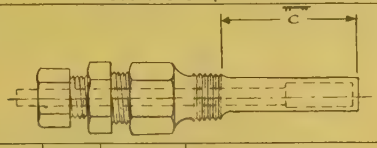
Column I
Plain Bulb Specifications



Column II
Unions Complete



Column III
Sockets Complete



BULB SPECIFICATION (FROM NAMEPLATE)	METAL	"D" INCHES	"J" INCHES	"S" INCHES	METAL	ST'D PIPE THREAD INCHES	PART NO. of COMPLETE UNION	METAL	ST'D PIPE THREAD INCHES	PART NO. OF COMPLETE SOCKET	STANDARD LENGTH "C" UNDER THREAD INCHES
CLASS I THERMOMETER BULBS											
1013-10-( )	Copper	3/8	10	(See Note 3 above)	brass	1/2	82920	bronze	1/2	84424	Minimum Socket length "C" is determined by sensitive length "S" plus minimum immersion of neck "J" (see note 4) Standard Class I socket lengths are: 2½"-3½" 5½"-7½" 12"-18" 24"-30"
1013-30-( )	Copper	3/8	30		brass	1/2	82920	bronze	1/2	84424	
1013-60-( )	Copper	3/8	60		brass	1/2	82920	bronze	1/2	84424	
1023-10-( )	Stain S.	3/8	10		Stain. S.	1/2	82921	Welded S.S.	1/2	84425	
1023-30-( )	Stain.S.	3/8	30		Stain. S.	1/2	82921	Welded S.S.	1/2	84425	
1023-60-( )	Stain.S.	3/8	60		Stain. S.	1/2	82921	Welded S.S.	1/2	84425	
1015-10-( )	Copper	5/8	10		brass	3/4	82923	bronze	3/4	84426	
1015-30-( )	Copper	5/8	30		brass	3/4	82923	bronze	3/4	84426	
1015-60-( )	Copper	5/8	60		brass	3/4	82923	bronze	3/4	84426	
1025-10-( )	Stain.S.	5/8	10		Stain. S.	3/4	84550	Welded S.S.	3/4	84427	
1025-30-( )	Stain.S.	5/8	30		Stain. S.	3/4	84550	Welded S.S.	3/4	84427	
1025-60-( )	Stain.S.	5/8	60		Stain. S.	3/4	84550	Welded S.S.	3/4	84427	
1034-10-( )	lead protected copper	1/2	10		brass or Stain. S.	3/4	82923 or 84550				
1034-30-( )		1/2	30								
1034-60-( )		1/2	60								
1116-10-( )	coil bulbs copper	3/4	10		brass	1	84551				
1116-30-( )		3/4	30		brass	1	84551				
1116-60-( )		3/4	60		brass	1	84551				
1126-10-( )	coil bulb	3/4	10		Stain. S.	1	84552				
1126-30-( )		3/4	30		Stain. S.	1	84552				
1126-60-( )	Stain.S.	3/4	60		Stain. S.	1	84552				
CLASS II THERMOMETER BULBS											
2013-10-040	copper	3/8	10	4	brass	1/2	82920	bronze	1/2	84424	5½-7½
2013-30-040	copper	3/8	30	4	brass	1/2	82920	bronze	1/2	84424	5½-7½-12-18-24
2013-60-040	copper	3/8	60	4	brass	1/2	82920	bronze	1/2	84424	5½-7½-12-18-24-30
2023-10-040	Stain.S.	3/8	10	4	Stain. S.	1/2	82921	Welded S.S.	1/2	84425	5½-7½
2023-30-040	Stain.S.	3/8	30	4	Stain. S.	1/2	82921	Welded S.S.	1/2	84425	5½-7½-12-18-24
2023-60-040	Stain.S.	3/8	60	4	Stain. S.	1/2	82921	Welded S.S.	1/2	84425	5½-7½-12-18-24-30
2015-10-017	copper	5/8	10	1.75	brass	3/4	82923	bronze	3/4	84426	2½-3½-5½
2015-30-017	copper	5/8	30	1.75	brass	3/4	82923	bronze	3/4	84426	2½-3½-5½-7½-12-18-24
2015-60-017	copper	5/8	60	1.75	brass	3/4	82923	bronze	3/4	84426	2½-3½-5½-7½-12-18-24-30
2025-10-017	Stain.S.	5/8	10	1.75	Stain. S.	3/4	84550	Welded S.S.	3/4	84427	2½-3½-5½
2025-30-017	Stain.S.	5/8	30	1.75	Stain. S.	3/4	84550	Welded S.S.	3/4	84427	2½-3½-5½-7½-12-18-24
2025-60-017	Stain.S.	5/8	60	1.75	Stain. S.	3/4	84550	Welded S.S.	3/4	84427	2½-3½-5½-7½-12-18-24-30
2034-10-070	lead protected copper	1/2	10	7	brass or Stain. S.	3/4	82923 or 84550				
2034-30-070		1/2	30	7							
2034-60-070		1/2	60	7							
2116-10-040	coil bulbs copper	3/4	10	4	brass	1	84551				
2116-30-040		3/4	30	4	brass	1	84551				
2116-60-040		3/4	60	4	brass	1	84551				
2116-10-040	coil bulbs Stain.S.	3/4	10	4	Stain. S.	1	84552				
2116-30-040		3/4	30	4	Stain. S.	1	84552				
2116-60-040		3/4	60	4	Stain. S.	1	84552				
CLASS III THERMOMETER BULBS											
3016-10-100	copper	3/4	10	10	brass	1	84551	bronze	1	84429	10½-12
3016-30-100	copper	3/4	30	10	brass	1	84551	bronze	1	84429	10½-12-18-24-30
3016-60-100	copper	3/4	60	10	brass	1	84551	bronze	1	84429	10½-12-18-24-30
3026-10-100	Stain.S.	3/4	10	10	Stain. S.	1	84552	Welded S.S.	1	84430	10½-12
3026-30-100	Stain.S.	3/4	30	10	Stain. S.	1	84552	Welded S.S.	1	84430	10½-12-18-24-30
3026-60-100	Stain.S.	3/4	60	10	Stain. S.	1	84552	Welded S.S.	1	84430	10½-12-18-24-30
3018-10-050	copper	1	10	5	brass	1¼	84568	bronze	1¼	84431	5½-7½
3018-30-050	copper	1	30	5	brass	1¼	84568	bronze	1¼	84431	5½-7½-12-18-24
3018-60-050	copper	1	60	5	brass	1¼	84568	bronze	1¼	84431	5½-7½-12-18-24-30

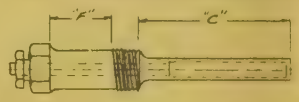
-continued over-

THE BRISTOL COMPANY
WATERBURY 91, CONN., U.S.A.

PARTS LIST FOR CONVERTIBLE THERMOMETER BULB FITTINGS

continued from page 1

Bulb SPECIFICATION (FROM NAMEPLATE)	METAL	"D" INCHES	"J" INCHES	"S" INCHES	METAL	ST'D PIPE THREAD INCHES	PART NO. OF COMPLETE UNION	METAL	ST'D PIPE THREAD INCHES	PART NO. OF COMPLETE SOCKET	STANDARD LENGTH "C" UNDER THREAD INCHES
3028-10-050	Stain. S.	1	10	5	Stain. S.	1½	84569	Welded S.S.	1½	84432	5½-7½
3028-30-050	Stain. S.	1	30	5	Stain. S.	1½	84569	Welded S.S.	1½	84432	5½-7½-12-18-24
3028-60-050	Stain. S.	1	60	5	Stain. S.	1½	84569	Welded S.S.	1½	84432	5½-7½-12-18-24-30
3119-10-060	averaging	3⅜	10	25 ft.	brass	1	84551	Extra heavy lagging sockets for High Pressure. Machined from steel forging. All fittings are brass.			
3119-30-060	bulbs*	3⅜	30	25 ft.	brass	1	84551				
3119-60-060	copper	3⅜	60	25 ft.	brass	1	84551				
3129-10-060	averaging	3⅜	10	25 ft.	Stain. S.	1	84552				
3129-30-060	bulbs*	3⅜	30	25 ft.	Stain. S.	1	84552				
3129-60-060	Stain. S.	3⅜	60	25 ft.	Stain. S.	1	84552				



								METAL	ST'D PIPE THREAD INCHES	PART NO. OF COMPLETE SOCKET	STANDARD LENGTH "C" UNDER THREAD INCHES
3038-10-11	lead pro-	1	10	11	brass	1½	84568				
3038-30-11	tected	1	30	11	or			solid	1	86187	10½
3038-60-11	copper	1	60	11	Stain. S.	1½	84569	steel	1½	87926	5½

*Union cannot slip on over whole bulb coil but must be slipped over the 25 ft. bulb tubing

UNION PARTS

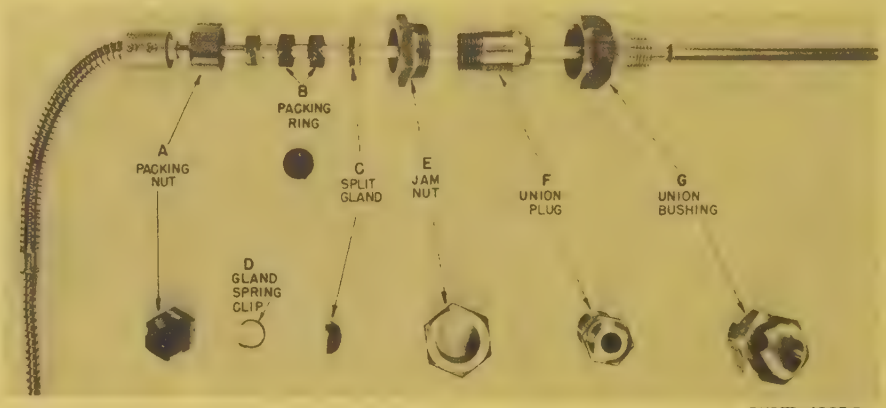
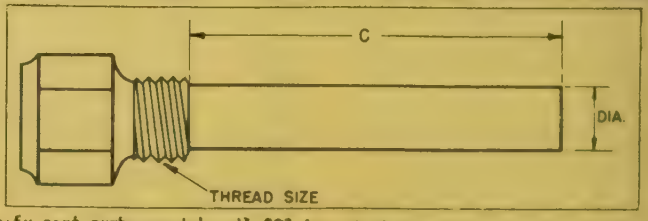


PHOTO 14263 B

For BULB SIZE (INCHES)	ST'D THREAD SIZE (INCHES)	METAL	A PACKING NUT	B PACKING RING (2 REQUIRED)	C SPLIT GLAND (4 REQUIRED)	D GLAND SPRING CLIP (2 REQUIRED)	E JAM NUT	F UNION PLUG	G UNION BUSHING	PART NO. OF COMPLETE UNION
3/8	1/2	brass	83923	84367	84014	86839	83921	83922	83920	82920
1/2 or 5/8	3/4	brass	83929	84368	84016	86840	83927	83928	83925	82923
3/4	1	brass	83929	84368	84016	86840	83927	83928	83926	84551
1	1¼	brass	84454	84977	84975	86841	84456	84455	84457	84568
3/8	1/2	S.S.	83930	84367	84015	86839	83933	83932	83931	82921
1/2 or 5/8	3/4	S.S.	83938	84368	84017	86840	83937	83936	83935	84550
3/4	1	S.S.	83938	84368	84017	86840	83937	83936	83939	84552
1	1¼	S.S.	84458	84977	84976	86841	84565	84459	84566	84569

Note: All sockets use exactly the same fittings as unions of the same thread size above, except that union bushing "G" is replaced by the socket.



SOCKETS ONLY

Be Sure to specify part number and length "C" in ordering sockets

FOR BULB SIZE (INCHES	STD. PIPE THREAD (INCHES)	METAL	SOCKET DIAM. D (INCHES)	PART NO. SOCKET ONLY	STANDARD "C" LENGTHS (INCHES) (SEE NOTES 2 & 4 PAGE 1 ON HOW TO ORDER)
3/8	1/2	bronze	1/2	84912	3½-5½-7½-12-18-24-30
1/2 & 5/8	3/4	bronze	3/4	84910	2½-3½-5½-7½-12-18-24-30
3/4	1	bronze	7/8	84914	10½-12-18-24-30
1	1¼	bronze	1 5/32	84916	5½-7½-12-18-24-30
3/8	1/2	Stain. S.	1/2	84913	3½-5½-7½-12-18-24-30
1/2 & 5/8	3/4	Stain. S.	3/4	84911	2½-3½-5½-7½-12-18-24-30
3/4	1	Stain. S.	7/8	84915	10½-12-18-24-30
1	1¼	Stain. S.	1 1/8	84917	5½-7½-12-18-24-30
3/8	3/4	Aluminum	7/8	85122	4 - 6 - 9

PARTS LIST Y19807

November 1952

SERIES "500" 8" & 12" CASES

STANDARD & PORTABLE

RECORDERS — INDICATORS — ACCESSORIES

-CONTENTS-

	PAGE NUMBER
BASIC STANDARD CASE	2 & 3
BASIC PORTABLE CASE	2 & 3
BASIC RECORDER	4 & 5
BASIC PORTABLE RECORDER	4 & 5
PEN MOUNTINGS	5
PEN ARMS	6
PENS	6
INK	7
INK BOTTLES	7
CHART DRIVES	7
BASIC DIAL TYPE INDICATOR	8

Be sure to state model and serial number of instrument when ordering parts.

THE BRISTOL COMPANY WATERBURY 20, CONNECTICUT

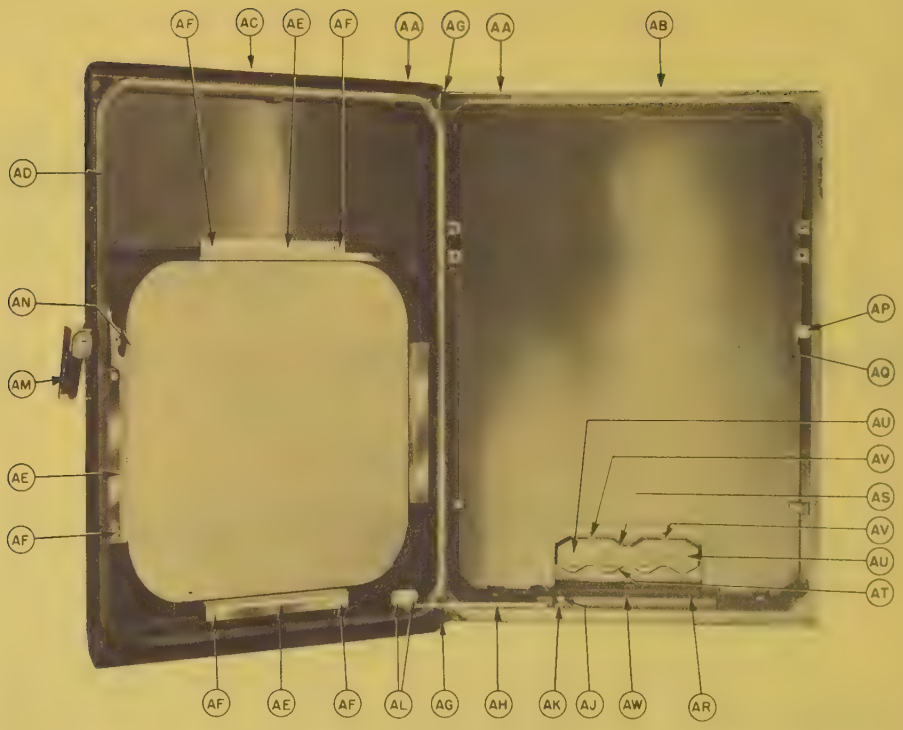


Figure 1 - Series "500" Case

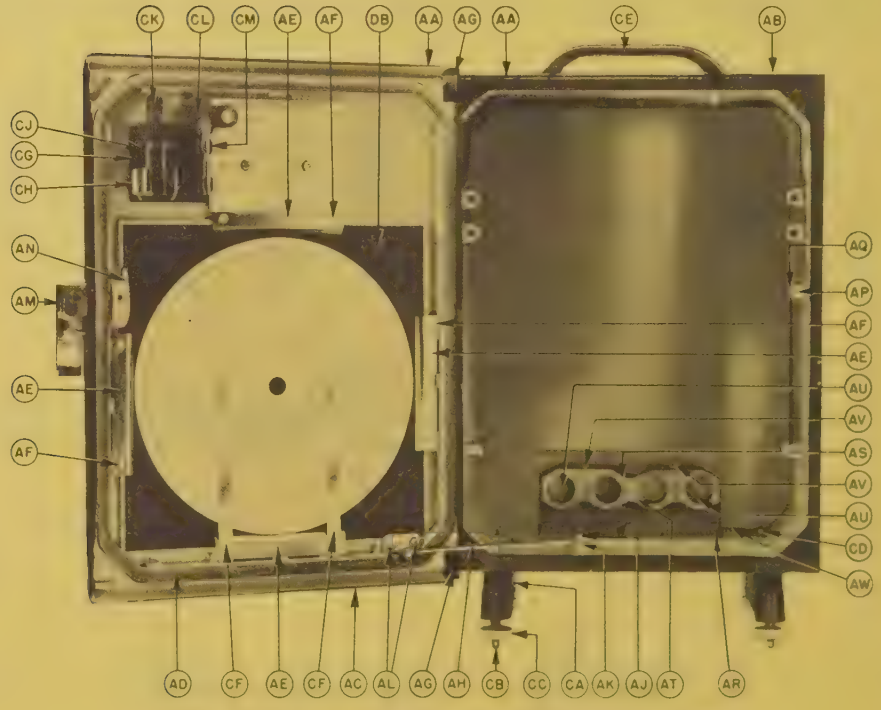


Figure 2 - Series "500" Portable Case

ITEM	DESCRIPTION	8 INCH CASE PART NUMBER		12 INCH CASE PART NUMBER	
	Note: Case sizes are determined by the nominal chart or dial dimensions: 8" and 12"				
AA	Case complete }				
AB	Case body } Order by model and serial numbers of instrument				
AC	Cover only }				
AD	Gasket (45" long)	82608		.....	
	Gasket (62" long)	.....		82608	
AE	Clips (3)	82663		82637	
	Clip (upper)	89261		89262	
AF	#6 x 1/4" self-tapping screw (8)	82656		82656	
AG	Door-hinge-pin bracket (2)	82654		82654	
	#10-32 x 1/2" screw for hinge pin (2)	92694		92694	
	Washer for hinge (2)	10075		10075	
AH	Door stop complete, including:	86520		86522	
	Bracket	86519		86519	
	Slotted Arm	86521		86523	
	Stud	86518		86518	
AJ	Door-stop screw	87392		87392	
AK	Collar for door-stop screw	44739		44739	
AL	#8-32 x 1/4" Fillister-head screw (2)	40066		40066	
AM	Door handle (with lock) } not including:	82615		82615	
	Door handle (without lock) }	82616		82616	
	Flat spring (not shown)	82630		82630	
AN	Hook complete including setscrew	88751		88751	
	#10-32 x 1/4" cone-point screw	82415		82415	
	Key for lock (not shown)	84726		84726	
AP	Roller for door hook	71283		71283	
AQ	Roller pin	82638		82638	
AR	Connection mounting plate (solid)	82653		82653	
AS	Connection mounting plate (clamping half)	82674		82674	
AT	Connection mounting plate (holding half)	83998		83998	
AU	Blank plug	82664		82664	
	Hex nut for 1/2" conduit connection (not shown)	84729		84729	
	Rubber grommet for electrical wiring (not shown)	84681		84681	
AV	#10-32 x 1" Fillister-head screw (2)	66546		66546	
AW	#10-32 x 5/16" Fillister-head screw (7)	67029		67029	
BA	Cup Washer	92031		92031	
BB	Screw	83848		83848	
BC	Nut	50706		50706	
BD	Screw	32193		32193	
BE	Mounting Bracket	92030		92030	
CA	Foot complete including Items CB and CC (2)	83053		83053	
	1/4"-20 x 1/2" Mounting screw (4) (not shown)	38451		38451	
	Washer for screw 38451 (4) (not shown)	39714		39714	
CB	Leveling screw (4)	82625		82625	
CC	Leveling-screw knob (4)	82626		82626	
CD	1/4"-28 x 1/8" Fillister-head screw (4)	84419		84419	
CE	Handle	83051		83051	
	#10-32 x 1/2" screw for handle (2) (not shown)	66541		66541	
	Washer for screw 66541 (2) (not shown)	20843		20843	
CF	Clamp for extra charts (2)	86514		86753	
CG	Mounting plate to hold bottle and key clips	86526		86526	
	Studs for mounting plate (2) (not shown)	86298		86298	
	Nut for mounting plate (2)	13775		13775	
CH	Bottle clip (2 used on 2 pen recorders)	38288		38288	
	#10-32 x 1/4" screw	39425		39425	
	#10-3/16" self-tapping screw (used on early models)	86545		86545	
CJ	1/4 oz. ink bottle (2 used on 2 pen recorders)	70628		70628	
CK	Bottle cap and dropper	86546		86546	
CL	Chart-drive key	84450		84450	
CM	Spring clips for chart-drive key (2)	86527		86527	
	#6-40 x 1/4" screw	18339		18339	
	#6 x 3/16" self-tapping screw (used on early models)	83999		83999	

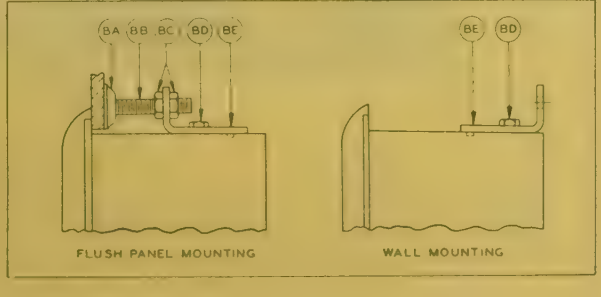


Figure 3
Series "500" Universal Mounting Bracket

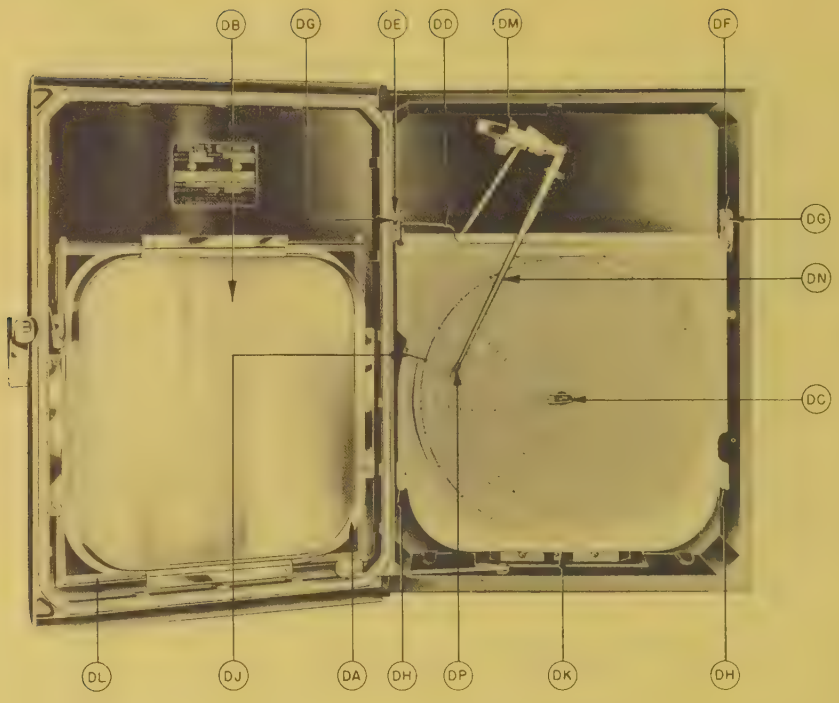


Figure 4 - Series "500" Recorder

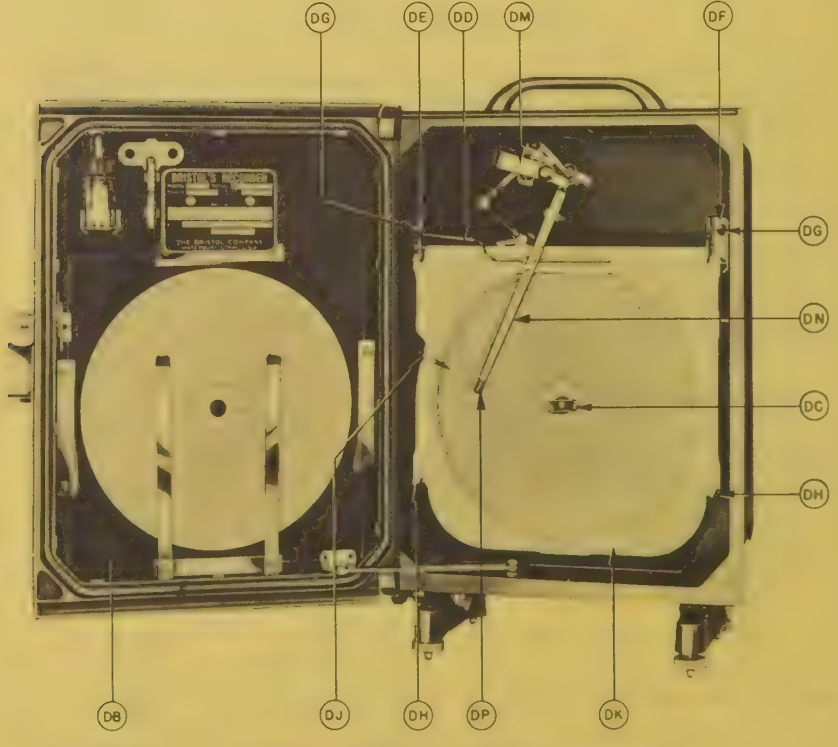


Figure 5 - Series "500" Portable Recorder

ITEM	DESCRIPTION	8 INCH CASE PART NUMBER		12 INCH CASE PART NUMBER	
DA	Aluminum shield	82657		82642	
DB	Glass	82662		82643	
	Metal blank	86515		86809	
DC	Chart hub (standard)	74986		74986	
	Chart hub (for dairy recorders)	86771		86771	
DD	Pen lifter, not including	90146		82648	
	pen-lifter bracket	90147		84103	
	#6-40 x 1/4" screw for bracket	86804		86804	
	washer	43040		43040	
DE	Chart-plate bracket (left)	82650		82650	
DF	Chart-plate bracket (right)	82651		82651	
DG	#10 x 5/16" screw (4)	85812		85812	
DH	Spring catch for chart plate (2)	82633		82633	
	#6-40 hex screw for spring catch (2)	82634		82634	
	#6-40 hex nut for spring catch (2)	20903		20903	
DJ	Time index	84724		84724	
	#2-64 x 3/16" screw for time index	67694		67694	
	#2-64 x 7/32" hex nut for time index	87118		87118	
DK	Chart plate (standard)	84727		84728	
	Chart plate for integrating flowmeter	.....		87674	
DL	Gasket (under glass or metal blank)	84725		84725	
DM	Pen mounting (see breakdown below)				
DN	Pen arm (see breakdown on page 6)				
DP	Pen (see breakdown on page 6)				

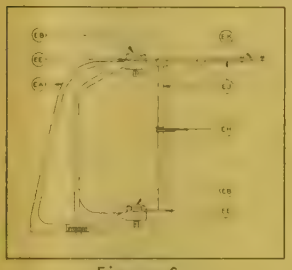


Figure 6

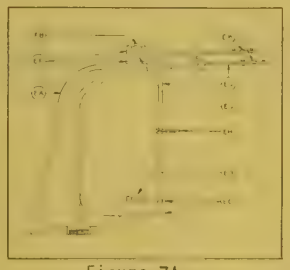


Figure 7A

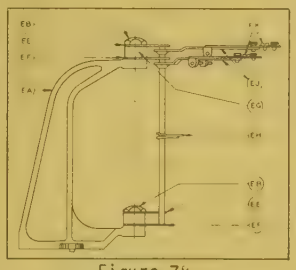


Figure 7B

Figure 7C

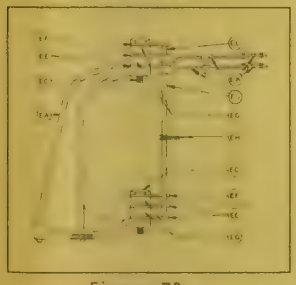


Figure 7D

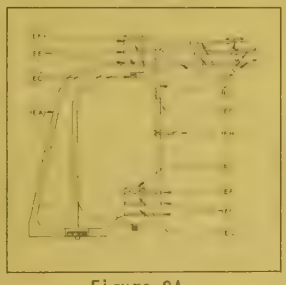


Figure 8A

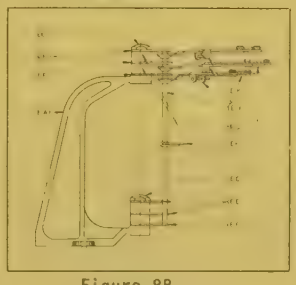


Figure 8B

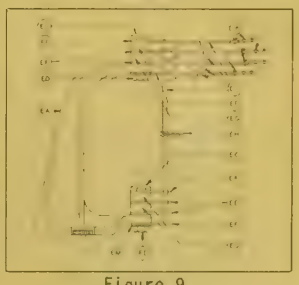
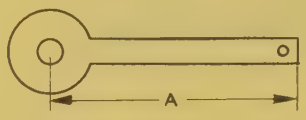


Figure 9

ITEM	DESCRIPTION	8 INCH CASE PART NUMBER		12 INCH CASE PART NUMBER	
Fig. 6	Standard single-pen mounting complete	84703		84703	
	Metavane transmitter pen mounting complete	89974		.....	
Fig. 7A	Standard two-pen mounting complete	84704		84704	
	Pen mounting complete for single-pen single-control unit free-vane controller	.....		86415	
Fig. 7B	Two-pen mounting complete for flowmeters with pressure pens	91695		91695	
Fig. 7C	Mounting complete for indicating free-vane controllers	91292		88277	
Fig. 7D	Pen mounting complete for Autoset free-vane controller	.....		88291	
Fig. 8A	Standard three-pen mounting complete	.....		84705	
	Pen mounting complete for two-pen single-control-unit free-vane controller	.....		86430	
Fig. 8B	Three-pen mounting complete for flowmeters with pressure and temperature pens	.....		91696	
Fig. 9	Standard four-pen mounting complete	.....		84706	
	Pen mounting complete for two-pen two-control-unit free-vane controller	.....		86432	
EA	Standard pen-arm mounting	84701		84701	
	Pen-arm mounting for four-pen instruments			91698	
	Standard pen-arm mounting for free-vane controllers	86412		86412	

ITEM	DESCRIPTION	8 INCH CASE PART NUMBER		12 INCH CASE PART NUMBER	
	Pen-arm mounting for two-pen two-control-unit free-vane controllers	.....		91699	
EB	6-40 x 7/16" screw	84170		84170	
EC	6-40 x 15/16" screw	.....		84171	
ED	6-40 Hex nut	.....		20903	
EE	Short tab (Item EF used on Metavane transmitters)	84272		84272	
EF	Long tab	84271		84271	
EG	Spacer	84172		84172	
EH	Straight lever arm with six holes	84110		84110	
	Straight lever arm with one hole at outer end:				
	 Dimension A = 15/16"	89972		.....	
	Dimension A = 1"	.....		88280	
	Dimension A = 1 1/16"	91291		.....	
	Dimension A = 1 5/16"	.....		86433	
	Dimension A = 1 9/16"	.....		86486	
	Straight lever arm with tapped hole at outer end:				
	Dimension A = 1 1/16"	.....		88278	
	Dimension A = 1 1/8"	91289		.....	
	Dimension A = 1 13/32"	.....		86435	
	Dimension A = 1 3/4"	.....		86414	
	Offset lever arm with four holes	.....		83734	
	Offset lever arm with one tapped hole	.....		86437	
EJ	Base end and shaft complete	84270		84270	
	Base end and shaft complete for Metavane transmitter	90809		.....	
EK	1-72 x 3/32" Special-Head Screw Included in Item EJ	85291		85291	
EL	Shaft for Autoset Unit	.....		84107	
EM	Washer	.....		87148	
Not Shown	10-32 x 1/2" Mounting Screw	66541		66541	
Not Shown	Washer	10075		10075	

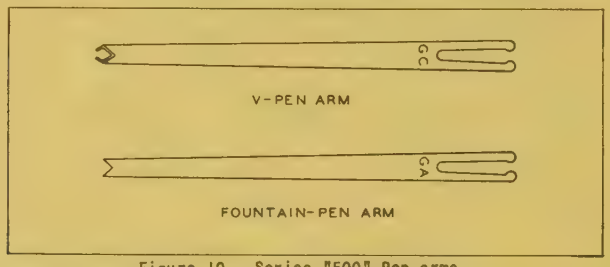


Figure 10 - Series "500" Pen arms

DESCRIPTION	PART NO.	
Pen arm marked:		
FA	84348	
FB	84349	
FC	84350	
FD	84351	
FE	83728	
FJ	93188	
FK	93189	
FL	94014	
GA	83725	
GB	83727	
GC	83724	
GJ	94073	
GK	94074	

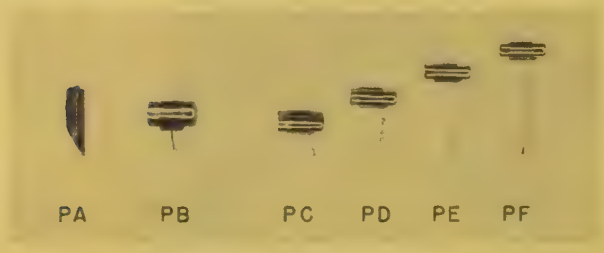


Figure 11 - Series "500" Pens

ITEM	DESCRIPTION	PART NUMBER	
PA	V-pen for single-pen instrument or 2-pen divided-chart instrument	42648	
	V-pen with closed back for 2-pen instrument	42650	
	V-pen with open back for 2-pen instrument	42649	
PB	Fountain pen for single-pen instruments (except Free-vane controllers) and 2-pen divided-chart instruments. 3-drop pens are standard, but 6-drop pens may be used if a larger reservoir is desired. Fine-bore pens are used in flowmeters, ammeters, voltmeters and all Metameter receivers; otherwise standard-bore pens are used.		
	Standard-bore 3-drop pen	30425	
	Fine-bore 3-drop pen	46108	
	Standard-bore 6-drop pen	42909	
	Fine-bore 6-drop pen	82499	
PC	Pen used in single-pen Free-vane controllers	32914	
	Pen nearest chart in multiple-pen instrument	32914	
PD	Pen second from chart in multiple-pen instrument	32915	
PE	Pen third from chart in multiple-pen instrument	32916	
PF	Pen fourth from chart in multiple-pen instrument	28577	
	Pen cleaning wire (not shown)	32900	

STANDARD INK*

DESCRIPTION	Temperature Range: -10°F to +110°F				
	FORMULA 1 RED	FORMULA 2 BLUE	FORMULA 3 GREEN	FORMULA 4 BLACK	FORMULA 5 PURPLE
1 oz. (with dropper)	6883	19084	28134	31673	26475
4 oz.	47975	47976	47977	47979	47978
1/2 pint	47980	47981	47982	47984	47983
1 pint	47985	47986	47987	47989	47988
1 quart	47990	47991	47992	47994	47993
1 gallon	65500	65501	65502	65504	65503

SPECIAL INK

DESCRIPTION	Temp. Range: -65°F to 0°F			+100°F to 400°F
	FORMULA 41 RED	FORMULA 42 GREEN	FORMULA 43 BLUE	FORMULA 51 RED
1 oz. (with dropper)	85601	85607	85613	83429
4 oz.	85602	85608	85614	83430
1/2 pint	85603	85609	85615	83431
1 pint	85604	85610	85616	83432
1 quart	85605	85611	85617	83433
1 gallon	85606	85612	85618	83434

*For quick drying ink, specify #20815 together with color and quantity desired. Brown, orange and yellow are also available as standard or quick drying ink.

INK BOTTLES

DESCRIPTION	PART NUMBER
1 oz. (without cap and dropper)	74610
Cap and dropper for 1 oz. bottle	74611
1/4 oz. (without cap and dropper) for portable recorders	70628
Cap and dropper for 1/4 oz. bottle	86546

CHART DRIVES

DESCRIPTION	8" or 12" Case PART NUMBER
Spring Driven, Single Speed Chart Drives:	
12 hour	84586
24 hour	84585
48 hour	89712
7 day	89713
Spring Driven, Two Speed Chart Drives:	
15 minute or 1 hour	89714
8 hour or 2 hour (for oven thermometers)	88433
8 hour or 2 hour	84590
24 hour or 96 min.	84591
3 day or 24 hour	84589
7 day or 48 hour	84588
7 day or 24 hour	84587
Electric, Single Speed Chart Drives:	
30 minute, 96 minute, 4 hour, 8 hour, 12 hour, 24 hour, 48 hour, 72 hour, 7 day, 30 day — These chart drives are available for 115 or 230 volts, 25, 50 or 60 cycles. Give type, voltage and frequency required.	
Mounting post for chart drives	84344

Figure 12 - Series "500" Dial Type Indicating Mechanism

ITEM	DESCRIPTION	8" Case PART NUMBER		12" Case PART NUMBER	
FA	Posts for dial plate (3)	83106		83106	
FB	Lever arm for multiplier unit	86795		86795	
FC	Linkage to measuring element		give model and serial number		
FD	Multiplier unit for gauges and Metameters	76885		76885	
	Multiplier unit for thermometers and flowmeters	71305		71305	
	Post for mounting multiplier unit (2) (not shown)	86791		86791	
FE	Mounting plate for multiplier unit	86794		86794	
FF	Pointer	72791		72908	
	Zero-stop bracket (not shown)	87345		87345	
	Outer dial plate (blank) (not shown)	.....		87909	
	Inner dial plate (blank) (not shown)	.....		87908	
	Dial plate for 8" recorders (blank) (not shown)	87346		.....	

Printed in U.S.A.

CASE CONNECTIONS & MEASURING SYSTEM COLOR CODE
FOR DIAL INDICATING & RECORDING THERMOMETER -1 TO 4 PENS

THE BRISTOL CO.
WATERBURY CONN. U.S.A.
DATE 7-21-47 DRAWN JJR
DRAWER NO 21
SHEET NO. 011037
REV. 4-12-48

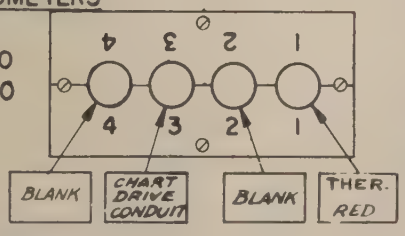
TUBING & CONDUIT CONNECTIONS ARE MADE TO NUMBERED POSITIONS OF SPLIT CONNECTION PLATE AS SHOWN BELOW

NOTE:
1. ALL CONDUIT CONNECTIONS ARE FOR 1/2" S.P.T.
2. OMIT CHART DRIVE CONDUIT FOR INDICATORS AND SPRING DRIVEN RECORDERS.

NUMBERS ARE FROM RIGHT TO LEFT LOOKING FROM REAR OF CASE

1 PEN THERMOMETERS

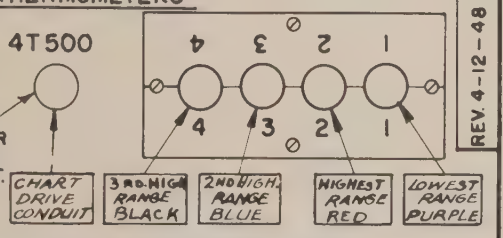
MODEL 1T500
" 1T530



4 PEN THERMOMETERS

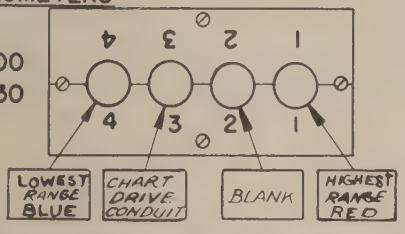
MODEL 4T500

SPECIAL DRILL IN CASE FOR RUBBER GROMMET.



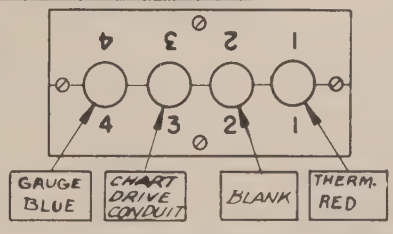
2 PEN THERMOMETERS

MODEL 2T500
" 2T530



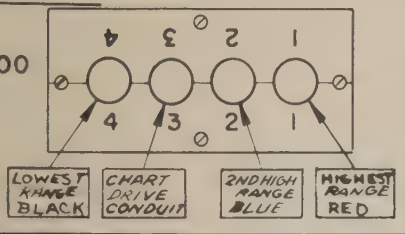
2 PEN - 1 GAUGE & 1 THERMOMETER

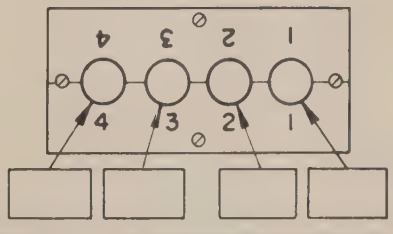
MODEL 2L500
" 2L530



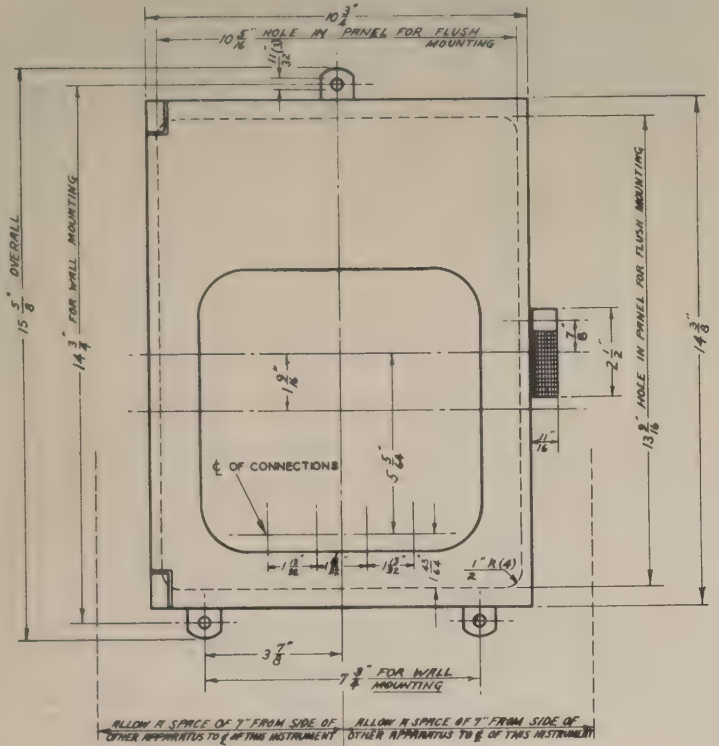
3 PEN THERMOMETERS

MODEL 3 500

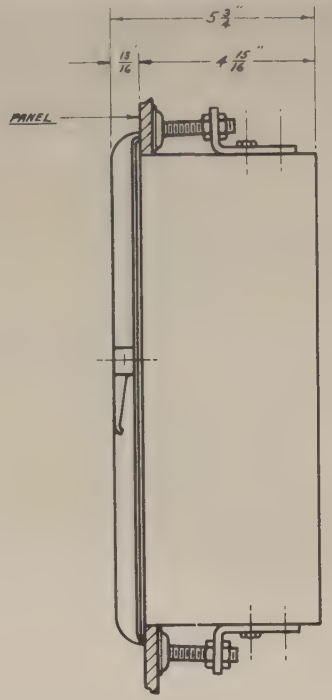




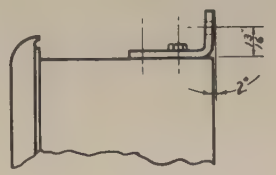
DO NOT SCALE THIS PRINT


10 3/4"
10 5/16" HOLE IN PANEL FOR FLUSH MOUNTING
11/32"
15 5/8" OVERALL
14 3/4" FOR WALL MOUNTING
14 3/8"
13 7/16" HOLE IN PANEL FOR FLUSH MOUNTING
1 7/8"
2 1/2"
1/16"
5 5/64"
℄ OF CONNECTIONS
1 9/16"
1 13/16"
1 9/32"
1 21/64"
1" R (4)
3 7/8"
7 3/4" FOR WALL MOUNTING
ALLOW A SPACE OF 7" FROM SIDE OF OTHER APPARATUS TO ℄ OF THIS INSTRUMENT
ALLOW A SPACE OF 7" FROM SIDE OF OTHER APPARATUS TO ℄ OF THIS INSTRUMENT

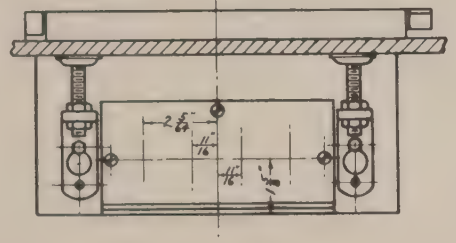
DETAIL OF FLUSH MOUNTED CASE



DETAIL OF WALL MOUNTED CASE



NOTES:-
1. FOR BOTTOM CONNECTED THERMOMETERS AND FOR GAUGES USING CLEANABLE DIAPHRAGM SEAL, INCREASE CUTOUT LENGTH TO 13 3/4" FOR TUBING CLEARANCE IF PANEL IS OVER 1/2" THICK.
2. MAXIMUM PANEL THICKNESS 1 7/8".



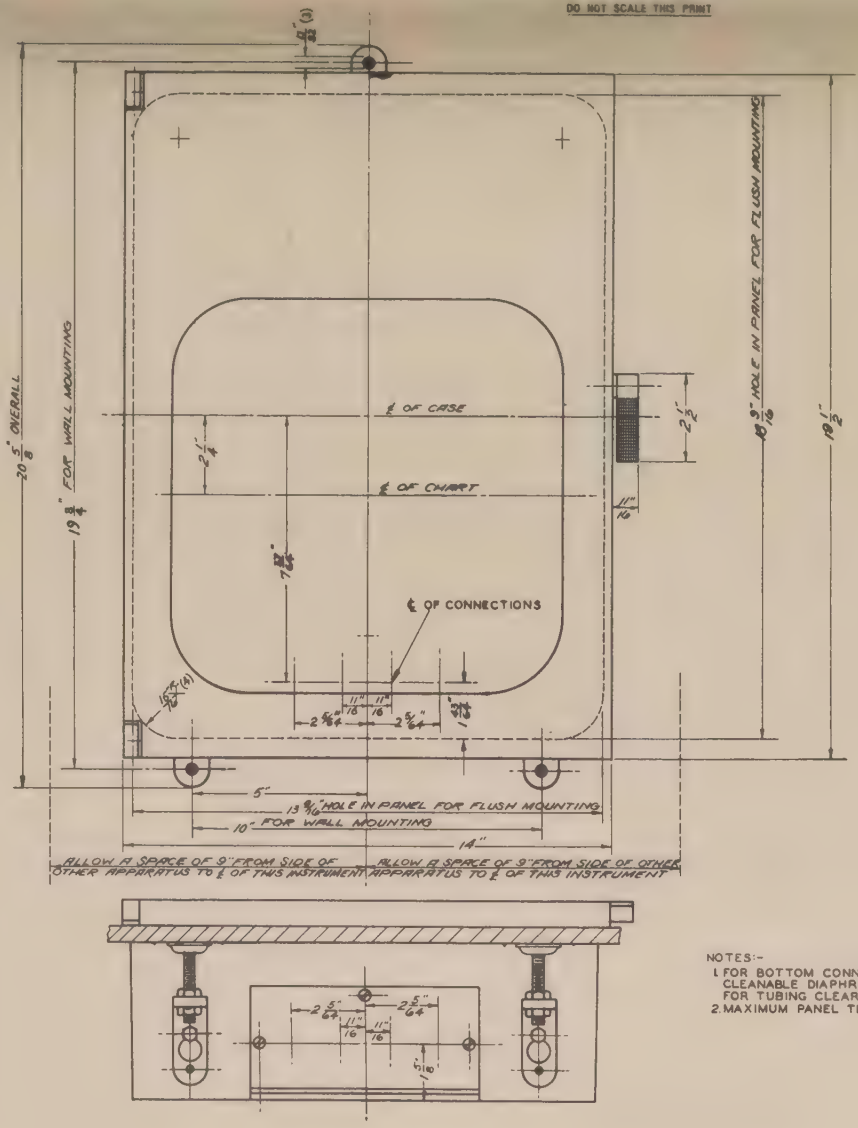
MOUNTING DIMENSIONS FOR 8" MODEL 500 CASE

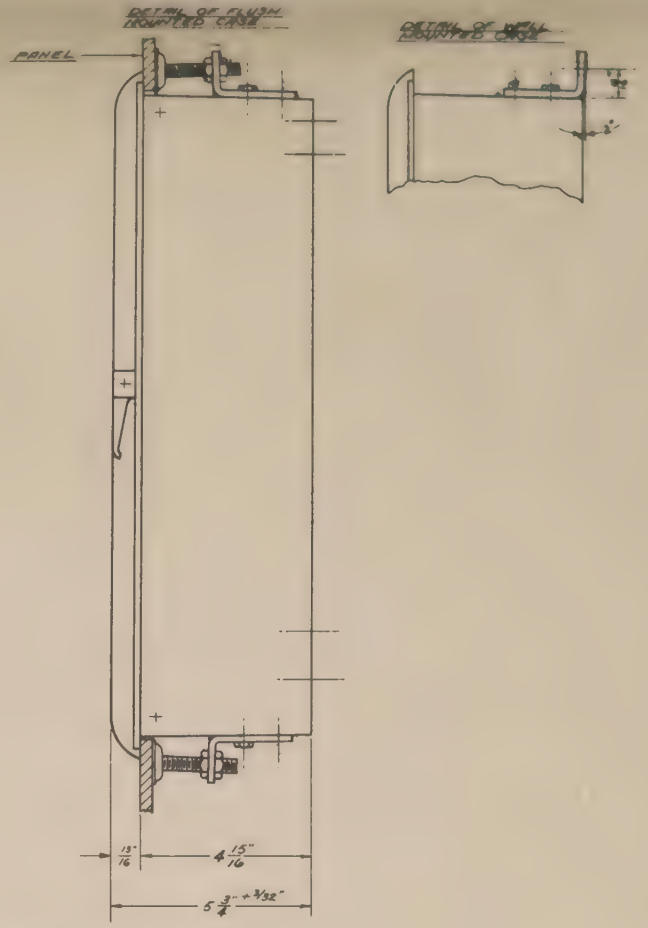
See reverse side for 12" case dimensions

THE BRISTOL COMPANY
WATERBURY 20, CONN., U.S.A.

INSTRUCTION Y19809
Issue No. 4 of 4/53 PAGE 1

DO NOT SCALE THIS PRINT

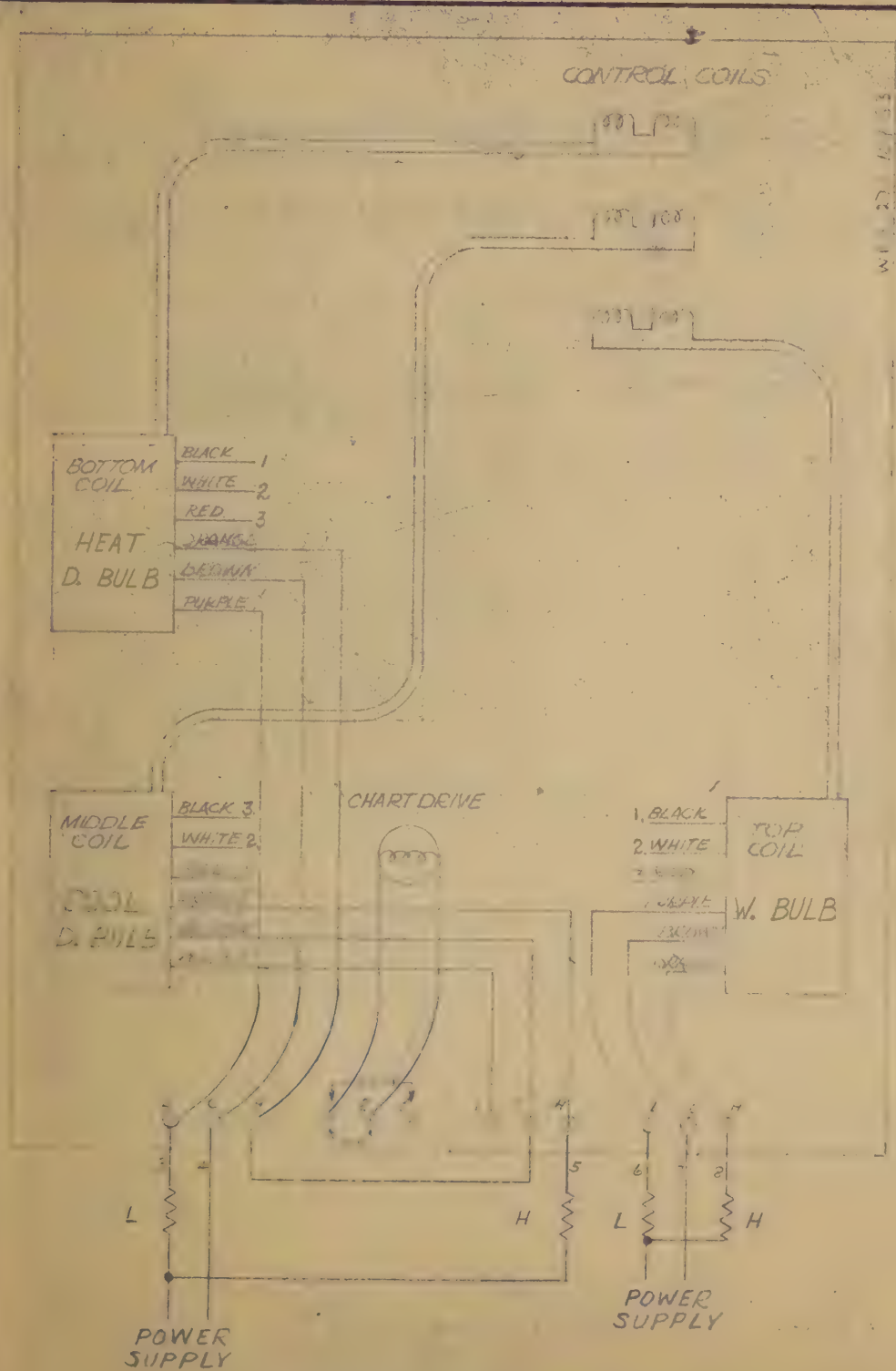

20 5/8" OVERALL
19 3/4" FOR WALL MOUNTING
℄ OF CASE
℄ OF CHART
℄ OF CONNECTIONS
10 3/16" HOLE IN PANEL FOR FLUSH MOUNTING
19 1/2"
2 5/64"
11/16"
5"
13 9/16" HOLE IN PANEL FOR FLUSH MOUNTING
10" FOR WALL MOUNTING
14"
ALLOW A SPACE OF 9" FROM SIDE OF OTHER APPARATUS TO ℄ OF THIS INSTRUMENT
ALLOW A SPACE OF 9" FROM SIDE OF OTHER APPARATUS TO ℄ OF THIS INSTRUMENT



NOTES:-
1. FOR BOTTOM CONNECTED THERMOMETER AND FOR GAUGES USING CLEANABLE DIAPHRAGM SEAL, INCREASE CUTOUT LENGTH TO 18 3/8" FOR TUBING CLEARANCE IF PANEL IS OVER 1/2" THICK.
2. MAXIMUM PANEL THICKNESS 1 1/8".

MOUNTING DIMENSIONS FOR 12" MODEL 500 CASE

See reverse side for 8" case dimensions



WIRING DIAGRAM — WET & DRY BULB
THERMOMETER CONTROLLER WITH
THREE ELECTRONIC CONTROL UNITS

THE BRISTOL CO.
WATERBURY, CONN., U. S. A.
DATE 2-13-53 DRAWN JAW
DRAWER NO.
SHEET NO. RC
SERIAL NO.
CUST. ORDER NO.
B. CO. ORDER NO.

FORM 3162CV

INSTRUCTION NO. H10010

(Issue No. 1 of 12/50)

INSTALLATION, OPERATION AND SERVICE OF BRISTOL'S WET- AND DRY-BULB RECORDING PSYCHROMETER USING FIXTURES 124, 176, 188 AND 197

TABLE OF CONTENTS

	PAGE
PART I GENERAL	2
PART II INSTALLATION	2
A. Unpacking the Instrument	2
B. Locating and Mounting the Recorder	2
C. Locating and Mounting the Fixtures	2
1. Fixture 124	2
2. Fixture 176	2
3. Fixture 188	3
4. Fixture 197	3
D. Installing the Thermometer Tubing and Bulbs	3
E. Installing the Wet-bulb Wick	4
F. Checking the Installation	4
PART III OPERATION	4
PART IV SERVICE	4
A. Routine Maintenance	4
B. Non-routine Maintenance	4
C. Repairs, Correspondence and Shipping	4

THE BRISTOL COMPANY WATERBURY 20, CONN.

Note: This instruction covers only the installation, operation and service of the psychrometer fixture. See separate instructions covering the recording, controlling system, etc., as required.

PART I GENERAL

Bristol's Wet- and Dry-Bulb Psychrometer using Fixtures 124, 176, 188 or 197 is an instrument for recording or controlling relative humidity. The entire measuring and recording system consists of a single two-pen recorder, two separate thermometer bulbs with tubing and measuring elements, and special fixture to provide a water supply for the wet bulb. Other fixtures are available to provide forced-air sampling where the normal circulation is not sufficient to get a representative sample. Separate instructions cover these fixtures.

Fixtures 124, 176, 188 and 197 are illustrated in this instruction.

PART II INSTALLATION

A. Unpacking the Instrument

The psychrometer comes with both bulbs permanently attached to the recorder. Be careful not to kink the tubing. Never move or handle the instrument case by the tubing.

Do not throw away the packing until you have found the mounting brackets, screws and other accessories, such as ink, charts, wicks, etc.

B. Locating and Mounting the Recorder

The psychrometer recorder should be mounted in a location as free as possible from dust, dirt, vibration, corrosive fumes and extremes of ambient temperature. Use a level on the instrument case to make sure that the instrument is exactly level.

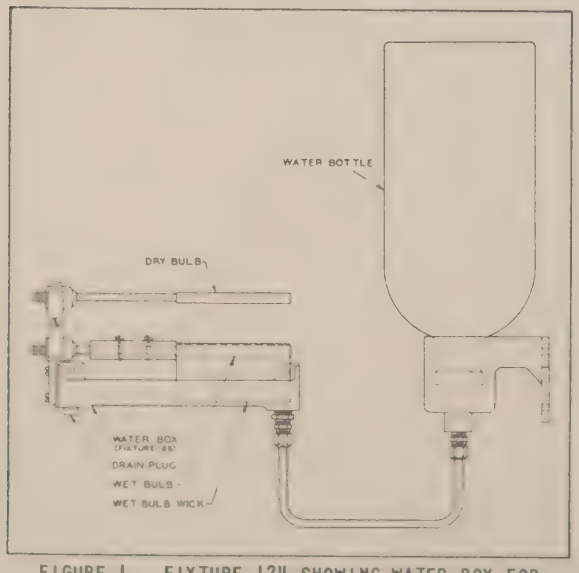


FIGURE 1. FIXTURE 124 SHOWING WATER BOX FOR CLASS I PSYCHROMETERS

C. Locating and Mounting the Fixtures

1. Fixture 124 (see Fig. 1). Mount Fixture 124 where the humidity is to be measured. The circulation of the air in the area of measurement should be as great as possible. If good circulation cannot be achieved, it may be necessary to go to forced-air sampling.

Attach the water box (reservoir) to a firm support. Then determine the correct position for the water bottle by filling it with water, inserting it in its holder and adjusting its height until the water level in the water box is about 3/16" from the top.

2. Fixture 176 (see Fig. 2). Mount Fixture 176 where the humidity is to be measured. The circulation of the air in the area of measurement should be as great as possible. If good circulation cannot be achieved, it may be necessary to go to forced-air sampling.

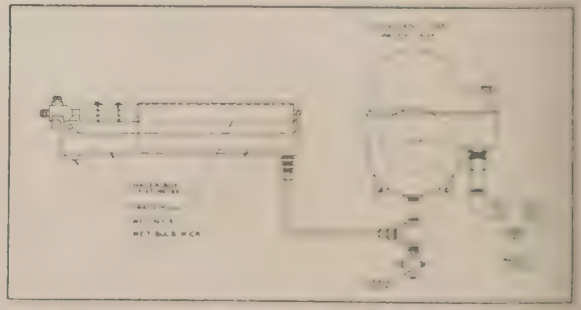


FIGURE 2. FIXTURE 176 SHOWING WATER BOX FOR CLASS II AND III PSYCHROMETER

Attach the water box and float tank t
a firm support (Note: One mounting-sc
hole is located inside the tank; take o
the cover). Connect a water supply to t

T as shown so that the water flows in the direction indicated by the arrow. Turn on the water to the float tank. The water box should fill up to within 3/16" from the top before the float tank automatically shuts off. To adjust the shut-off level, remove the cover from the float tank and turn the adjusting screw on the valve lever arm. Test for the correct shut-off level by draining the water box (by means of the petcock) and allowing it to fill up again.

3. Fixture 188 (see Fig. 3). Mount Fixture 188 where the humidity is to be measured. The circulation of the air in the area of measurement should be as great as possible. If good circulation cannot be achieved, it may be necessary to go to forced-air sampling.

Fixture 188 requires a manually regulated water supply which is brought in thru a hole in the bottom of the water box. A drain pipe is also required. This must be connected to the hole which has the drain boss. It is recommended that a needle valve be used for regulating the flow. Adjust the rate of flow so that the water box overflows continuously at a minimum rate.

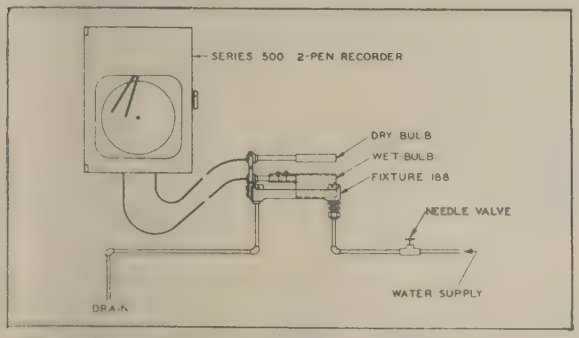


FIGURE 3. FIXTURE 188 SHOWING A COMPLETE CLASS I PSYCHROMETER INSTALLATION

4. Fixture 197 (see Fig. 4). Mount Fixture 197 where the humidity is to be measured. The circulation of the air in the area of measurement should be as great as possible. If good circulation cannot be achieved, it may be necessary to go to forced-air sampling. The wet bulb in Fixture 197 takes a porous alundum sleeve instead of a wick. This sleeve is kept wet by a constant-level tank. Installation of the bulb and sleeve is covered in paragraph D below.

Attach the bulb mounting bracket and float tank to a firm support (Note: One mounting-screw hole is located inside the tank; take off the cover). Connect a water supply to the T as shown so that the water flows in the direction indicated by the arrow. Turn on the water to the float tank. The alundum sleeve and wet bulb must be in the fixture to check the water level (see paragraph below for installation instructions). The water level maintained by the float tank should be just high enough to keep the sleeve wet but not high enough to allow water to run out of the overflow hole in the top of the alundum sleeve. To adjust the shut-off level, remove the cover from the float tank and turn the adjusting screw on the valve lever arm. Test for the correct shut-off level by draining the water from the sleeve (by means of the petcock) and allowing it to fill up again.

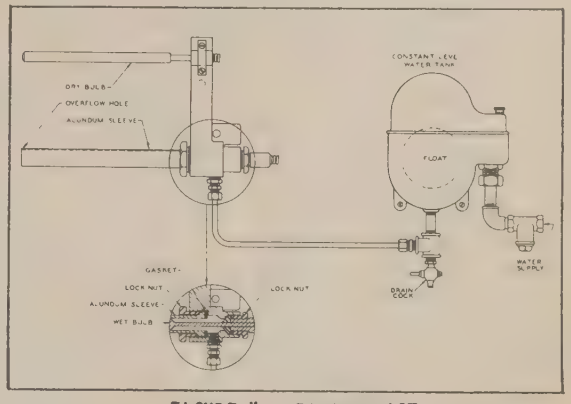


FIGURE 4. FIXTURE 197

D. Installing the Thermometer Tubing and Bulb

1. Tubing. The installation and protection of thermometer tubing are covered in separate instructions included with each psychrometer.

2. Bulbs. The dry bulb is identified by red markings and its temperature is recorded by the red pen. The wet bulb has blue markings and its temperature is recorded by the blue pen.

In Fixtures 124, 176 and 188, class I wet and dry bulbs are mounted vertically (one above the other) on a bracket as shown in Fig. 1. Class II or III wet and dry bulbs are mounted horizontally (side by side) as shown in Fig. 2. Remove the bulb clamp, insert the bulbs and clamp them securely to the mounting bracket.

In Fixture 197 the dry bulb is clamped to the top of the bracket as shown in Fig. 4. The wet bulb is mounted as shown in the cross-sectional view in Fig. 4. Be sure that the overflow hole in the alundum sleeve is at the top of the sleeve.

E. Installing the Wet-bulb Wick

Three linen or cotton wicks are provided for the wet bulb. No other type of wick should be used. One is installed on the bulb, one should be kept in pure water for quick replacement, and one is kept as a spare.

Slide the wick onto the wet bulb with the flap towards the neck of the bulb. The wick must cover the entire sensitive portion of the bulb, and the flap must be wound around the neck of the bulb and fastened securely with thread or string. The main section of the wick, of course, must hang into the water box and be well into the water at all times.

F. Checking the Installation

Before putting your psychrometer into permanent operation, check the following items:

1. The recorder chart drive must be turned on.
2. The recorder pens must be filled with the proper color ink and should trace a clean, legible record.
3. The water supply must be turned on.
4. The wick must be clean and thoroughly wet.
5. The circulation of air at the bulbs should be as great as possible. It is generally considered advisable to have air moving at a velocity of 15 ft./sec. over the bulbs to obtain the most accurate readings.

PART III OPERATION

To operate the Bristol Wet- and Dry-Bulb Pyschrometer after it has been completely and correctly installed, it is only necessary to turn on the recorder chart drive. To determine the relative humidity of the atmosphere under measurement, refer to the Relative Humidity Table included with this instruction. Read the difference between the two pen records anywhere on the chart where the humidity is desired. Also read the dry-bulb temperature at the same spot. The relative humidity is indicated on the table where the dry-bulb temperature and the difference between the wet- and dry-bulb readings intersect. This table is calculated for normal atmospheric pressure.

PART IV SERVICE

A. Routine Maintenance

The Bristol Psychrometer will give many years of accurate and continuous service if a few simple routine-service procedures are followed:

1. The water box should never be allowed to become empty. Keep it filled with pure water.

2. Clean the thermometer bulbs as often as experience shows it to be necessary. A film of dirt or dust can cause inaccuracies.

3. Change the wet-bulb wick often. It is suggested that one of the spare wicks be kept in pure water ready for immediate installation while the old wick is taken out of service for cleaning. Wash the used wick in a mild solvent (like soap and water) to get rid of mineral deposits and dirt that may have been in the water supply.

B. Non-routine Maintenance

The service section of the standard thermometer instructions furnished with the psychrometer covers the non-routine maintenance problems associated with thermometer systems.

When checking your wet- and dry-bulb psychrometer against a standard (hygrometer or sling psychrometer), be sure that the test measurements are taken at the location of the wet and dry bulbs.

C. Repairs, Correspondence and Shipping

If the psychrometer cannot be repaired with the information furnished, it should be shipped to the nearest Bristol Company Branch Factory or Main Factory at Waterbury for repair or replacement. Do not ship instruments to Branch Offices. Be sure to mark your return address plainly.

In all correspondence please mention the instrument model and serial number (as listed on its nameplate) and your repair order number. Address all correspondence to the Bristol Company Branch or Main Offices, a list of which is found in this instruction manual.

Printed in U.S.A.

RELATIVE HUMIDITY TABLE

| DRY BULB READING F | DIFFERENCE BETWEEN WET AND DRY BULB READINGS DEG. FAHR. PRESSURE 30." | | |

PERCENT RELATIVE HUMIDITY FOR DRY BULB TEMPERATURES OF 0 TO 100°C

PHOTO NO 12785

| DRY BULB TEMP. °C | WET BULB DEPRESSION PSYCHROMETRIC DIFFERENCE (DEGREES C.) | | |

INSTRUCTION NO. W18202
(Issue No. 2 of 4/56)

INSTALLATION AND OPERATION

BRISTOL'S TIME PROGRAM CONTROLLER

MECHANICAL LINK TYPE

NOTE: This instruction covers only the installation and operation of the Time Program Controller. See separate instructions covering installation and service of the measuring system, cutting of cams, recording system and control system as required.

PART I GENERAL DESCRIPTION

This instrument is designed to control any measured variable, such as temperature, pressure, etc., by means of pneumatic or electronic control equipment built into the case. The set point, instead of being shifted manually as on standard controllers, is shifted continuously by a cam follower sliding on a cam cut according to the desired program.

Time Program Controllers are made up in either single case, non-indicating, non-recording types or two case recording types. The two case controllers are mounted on a small panel with interconnections as required. Some of the features described in paragraph A below may be omitted to meet certain customer requirements.

A. Functions of Various Parts

1. Cam Motor. The cam motor will operate when the toggle switch on front of door is thrown to the "on" position and the snap action switch is in its running position. It will stop operating when the cam and index pointer* drop below the temperature, pressure, etc., to which the snap action switch has been set. The snap action switch is set by means of the red knob in the upper part of the case. The cam motor may be stopped at any time by turning the toggle switch to the "off" position.

2. Green Light. This light shows that the cam motor is running.
3. Red Light. This light is on whenever the cam motor is stopped.

4. Toggle Switch. This switch is used to start and stop the cam motor. When the toggle switch is thrown to the "on" position and the snap action switch is in its running position, the cam motor starts and the green light goes on.

* Index pointers are used only on two case jobs.

Control will then proceed as directed by the contour of the cam. When the cam follower drops towards the center of the cam at the end of the cycle, the cam motor stops, the green light goes off and the red light goes on. If there is an external siren or bell, it will start to sound and will continue to sound until toggle switch is thrown to "off". Alarm circuits are usually provided on pneumatic type program controllers. If there is no bell or siren connected to the alarm terminals, the toggle switch may be left in the "on" position as in that case only the red light will be lit.

5. Snap Action Switch. The function of this switch is to automatically stop the cam motor at the end of the desired period. This is accomplished by cutting the cam with a sharp drop at the end of the cycle. The snap action switch can be adjusted by means of the red knob to stop the cam motor whenever the cam follower drops to any desired point.

PART II INSTALLATION

See separate instructions covering the installation of the case, control system and how to cut cams. See nameplate of instrument for proper voltage and frequency. Proper wiring diagrams are furnished for each controller.

PART III OPERATION

Turn toggle switch to the "off" position. With power turned on, red light will light but cam motor will not run. By means of key furnished, turn cam counterclockwise until cam follower is at the proper starting point.

Turn toggle switch to "on". Motor should start, green light lights and red light goes out.

As the cam follower mechanically moves the set-point index in the case, control will now start and will continue until cam follower drops towards the center of the cam. The snap action switch then stops the cam motor, green light goes out and red light and alarm go on. Alarm can be stopped by throwing toggle switch to "off". If there is no external alarm signal hooked up to the controller, the toggle switch may be left in the "on" position as only the red light will be on.

The controller is started on another cycle by simply turning the cam until the green light goes on.

4/56

The Bristol Company
Waterbury 20, Connecticut, U.S.A.

INSTRUCTION NO. Y19174

(Issue No. 1 of 11/49 - Replaces 2662B & 3816)

METHOD FOR CUTTING CAMS FOR TIME-PROGRAM CONTROLLERS

UNPACKING: Be sure to remove shipping clamp holding cam follower to cam-motor hub before attempting to operate controller.

The following instruction describes the marking and cutting of a time-temperature-program cam. It applies equally to cam cutting for any other measured-variable program controller.

A. General

1. Note that curved time lines printed on cams may curve either one way or the other as illustrated in the two photographs attached. Select as a working example that photo similar to the cam being cut.

2. Cams may be easily cut with ordinary tin shears.

B. Marking Time Schedule on Cam

1. All cams should rotate in a counterclockwise direction. In laying out time schedule, always proceed in the opposite or clockwise direction as shown in photos.

2. Note time required for one revolution of cam. This time may be found on face plate of cam-driving mechanism and nameplate of the instrument. Count number of time intervals printed on cam and determine number of minutes or fraction of an hour corresponding to one time interval. (Examples are given below.)

For a uniform temperature rise, compute number of degrees per time interval and mark cam accordingly in a dotted, smooth curve. Sharp pencil is satisfactory for marking temperature curve on metal cams. This dotted line is not quite correct since diameter of the cam-follower roller causes a slight error both in time and temperature. However, if this error is not objectionable, cam can be cut on dotted line by a pair of tin-snips. Any irregularities may be smoothed out by means of a small file.

It is obvious that too steep a rise in the cam would require considerable power in the cam-driving mechanism. The practical limit is an angle of about 60° from the concentric circles representing the value of the measured variable.

C. Marking of Cam to Compensate for Radius of Cam-Follower Roller

1. As mentioned above, the dotted line laid out from the desired time schedule is only approximately correct. Inspection of photos will show error which corresponds to difference between dotted and solid lines. If it is desirable to eliminate this error in cutting cam, proceed as below.

After dotted line has been laid out as per paragraph B, a pair of dividers may be used to scribe a solid line 3/32" inside the dotted line as shown on photos. Cut cam along this solid line.

2. Example A. See Figure 1

Time required for one revolution of cam: 6 hours or 360 minutes

Number of time intervals printed on cam: 180

Time corresponding to one interval: 2 minutes

Raise temp. to 90°F in 10 min.
Hold temp. at 90°F for 60 min.
Raise temp. to 210°F in 60 min.
Hold temp. at 210°F for 60 min.

- over -

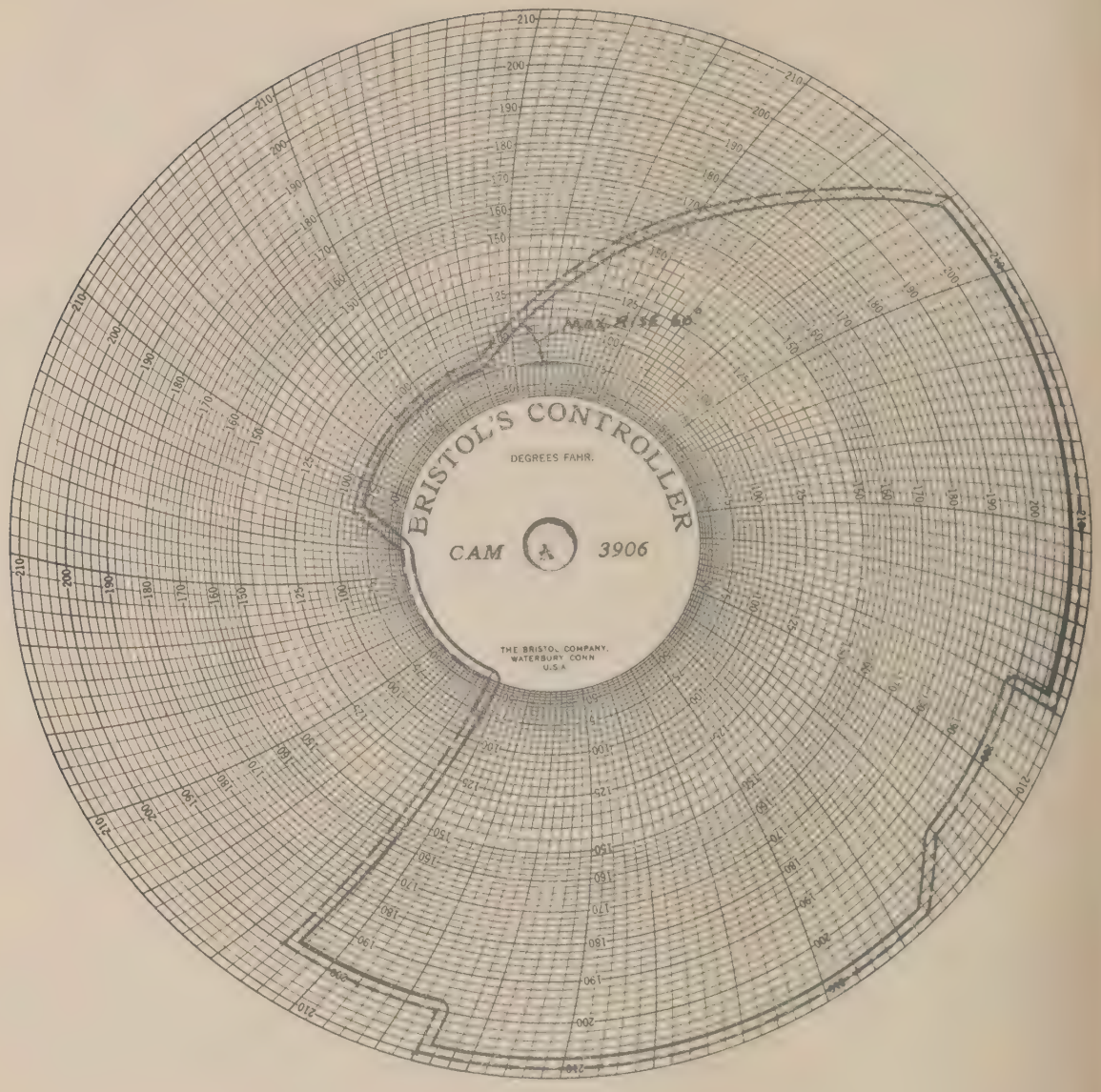


FIG. 1

Lower temp. to 200°F
Hold temp. at 200°F for 20 min.
Raise temp. to 210°F in 6 min.
Hold temp. at 210°F for 60 min.
Lower temp. to 200°F
Hold temp. at 200°F for 20 min.

Temperature drops: End of schedule.

3. Example B. See Figure 2.

Time required for one revolution of cam: 12 hours or 720 minutes

Number of time intervals printed on cam: 144

Time corresponding to one interval: 5 minutes

Raise temp. to 70°C in 40 min.
Hold temp. at 70°C for 60 min.
Raise temp. to 110°C in 80 min.
Hold temp. at 110°C for 60 min.
Raise temp. to 150°C in 40 min.
Hold temp. at 150°C for 120 min.
Lower temp. to 70°C in 80 min.
Hold temp. at 70°C for 45 min.
Lower temp. to 50°C

4. Schedule Records. It is advisable to enter each different time-tempera-

- con'd. on page 3 -

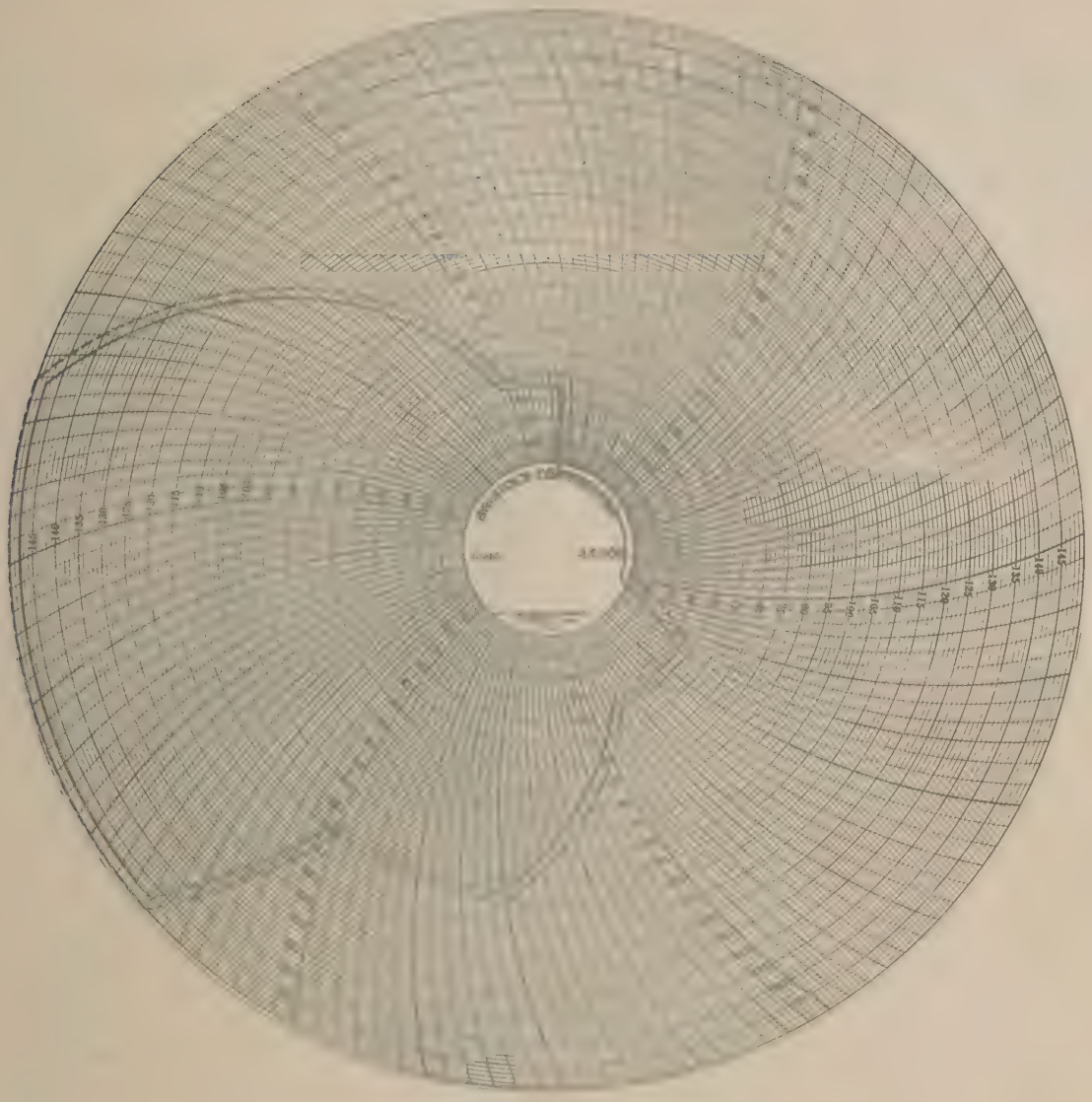


FIG 2

ture or time-pressure cam schedule on a card which is numbered and filed for convenient reference. The card numbers may be marked on the corresponding cams and the cams filed numerically.

5. Blank Cam. In case a blank cam is furnished, a paper chart may be pasted on the blank and the cam then cut as per above instructions.

D. Punching Holes in Cam

This paragraph applies only to those time-program controllers with jet-arrangement cam follower.

After cam has been cut as directed above, the holes required for manual operation points should be punched as follows:

The holes should be punched such that the jet on the cam follower will be uncovered and then covered. The operating point will be at the point of recovering the jet or at the trailing edge of the hole.

The placing of the hole will be such that the trailing edge will be on the time arc of the operation desired. This may be according to time or temperature position.

When the time arc for punching is determined, measure in 13/32" and punch the

- over -

hole. This distance is the amount of offset between the jet and cam-follower roller. The hole should be 1/16" in diameter.

Care should be taken when cutting cam profiles and laying out cam schedules to see that rises and drop-offs are not at extreme angles to permit the jet to become uncovered.

The cams may be punched with a hand punch or drilled with a 1/16" drill.

Printed in U.S.A.

The Bristol Company
Waterbury 20, Conn.

Instruction W-18220
Issued April 1954

HOW TO ORDER PARTS AND SUPPLIES

FOR BRISTOL PRODUCTS

In all correspondence concerning any product of the Bristol Company, always give the model and serial number of the product concerned. Send your purchase order or quotation request to the nearest Bristol Company Branch Office (see the back of this sheet for addresses).

REPLACEMENT PARTS

When ordering replacement parts look up the part name and number in the parts list provided with the instructions that came with your product. When you cannot find a part number, give an accurate description of the part. If you have mislaid your parts list write for a new one giving the model and serial number of the product.

CHARTS

In ordering charts for recorders, give the chart number (printed on the chart and also on the instrument name plate).

Avoid inconvenient emergency orders by keeping a six months supply of charts on hand for each of your recorders.

THERMOCOUPLES

Pyrometer thermocouples should be ordered from Bulletin P-1238. Be sure to specify the catalog number and the length. If you do not have Bulletin P-1238, write for one.

Pyrometer users should always have a supply of spare thermocouples.

SAMPLE PURCHASE ORDER:

QUANTITY REQUIRED	DESCRIPTION	PART, CHART OR CATALOG NUMBER
1000	Charts, 0° to 1500°F	5342
5	7-day electric chart drive for 115 volts, 60 cycles	86226
4	Pen arms marked CD	49703
1	Knurled plastic knob on outside of case, ½" diameter, 3/16" hole for moving set-point index	none given
1	1 oz. bottle red ink	6883
	The above parts are for a Bristol thermometer controller Model 1T1X500B-2, serial number 767211.	
4	IC thermocouples, length 30"	3BS14N2
	The above thermocouples are for a Bristol pyrometer Model 487-L, serial number 202953	

THE BRISTOL COMPANY · Waterbury 20, Conn.

BRANCH OFFICES

ALABAMA
Birmingham 3, 324 Comer Building 3-0034
CALIFORNIA
Los Angeles 58, 2181 E. 25th Street ..... Ludlow 8-4109
San Francisco 7, 40 Berry Street ..... Garfield 1-5462
COLORADO
Denver 4, 1236 Elati Street ..... Cherry 4-1505
CONNECTICUT
Hartford ..... Enterprise 4050
Waterbury 20, Bristol Road ..... Plaza 6-4451
DELAWARE
Wilmington 4-1183
DISTRICT OF COLUMBIA
Washington ..... Republic 7-0655
GEORGIA
Atlanta 3, 231 Healey Building ..... Walnut 7607
ILLINOIS
Chicago 11, 351-363 E. Ohio Street ..... Whitehall 4-2190
INDIANA
Indianapolis ..... Liberty 6-1889
LOUISIANA
New Orleans WX-2881
MARYLAND
Baltimore 2, Room 501, Mathieson Bldg. ..... Saratoga 7-2427
MASSACHUSETTS
Boston 16, 802 Statler Building ..... Hubbard 2-1728
MICHIGAN
Detroit 21, 10329 W. McNichols Rd. ..... University 4-4284
MINNESOTA
Minneapolis, P. O. Box 1101 ..... Atlantic 0714
MISSOURI
Kansas City, 300 Crawford Building ..... Harrison 1-7301
St. Louis 2, 434 Cotton Belt Building ..... Chestnut 1-7892
NEW JERSEY
Newark, 972 Broad Street ..... Mitchell 2-6823
NEW YORK
Buffalo 7, 1807 Elmwood Avenue ..... Delaware 3754
New York 19, 250 West 57th Street ..... Circle 5-4953
No. Syracuse, P.O. Box 177 66-3653
NORTH CAROLINA
Charlotte, P. O. Box 3180 ..... Franklin 5-7658
OHIO
Akron ..... Enterprise 4146
Cincinnati 37, 1717 Section Rd., Room C-4 ..... Elmhurst 0328
Cleveland 2, 8905 Lake Avenue ..... Atlantic 1-6924
Columbus 15, 101 N. High Street ..... Capitol 1-6133
OKLAHOMA
Tulsa 3, 304-A Daniel Building ..... Luther 4-6468
PENNSYLVANIA
Philadelphia 7, Market St. National Bank Bldg. Rittenhouse 6-2386
Pittsburgh 12, 210 E. Parkway ..... Fairfax 1-5190
TENNESSEE
Knoxville, P. O. Box 202 5-5992
TEXAS
Houston 19, 1705 West Gray Avenue ..... Jackson 4-2881
UTAH
Salt Lake City 1, 208 S.W. Temple 22-5553
WASHINGTON
Seattle 1, 203 White Building ..... Elliott 3361
WISCONSIN
Milwaukee 2, 735 N. Water St., Rm. 1327 ..... Broadway 6-4393

BRANCH FACTORIES

CHICAGO 11, ILL. — 351-363 East Ohio St.

SAN FRANCISCO 7, CAL. — 40 Berry Street

AFFILIATED COMPANIES

In Canada
THE BRISTOL COMPANY OF CANADA LIMITED
71-79 Duchess Street, Toronto 2, Ontario — Phone: Empire 3-3421
Branch Office at 1529 Drummond Street, Montreal 2, Quebec
Phone: Avenue 8-5141

In Great Britain
BRISTOL'S INSTRUMENT CO., LTD.
Lynch Lane,
Weymouth, Dorset, England

BRISTOL'S

Printed in U.S.A.

BRISTOL'S

A Recorder Is No Better Than Its Chart. For 40 years Bristol engineers have worked to better methods for producing recording instrument charts. Today, all charts are printed from masters prepared from engine engraved wax originals—a method developed by us. Cooperation with our paper suppliers has produced custom made chart papers with special inhibitors to retard moisture absorption, special sizing to give just right inking, lowest dimension changes due to humidity, and perfect flatness. Paper stocks are "cured" at constant humidity & temperature until absolute uniformity of dimensions is assured and then printed in an air conditioned shop. Printing and center hole punching are done simultaneously, achieving perfect concentricity. The result is charts yielding the highest accuracy of performance under a wide variety of conditions. Bristol prints over 600,000 pounds of charts yearly. Bristol instruments are guaranteed only when using Bristol's Charts.

Buy Charts in Quantities and Save. Discounts up to 50 and 40% are allowed on charts purchased in quantities.

Bristol's Annual Chart Requirement Plan. Enables large users to place orders for as few as 1,000 charts at a time, yet receive discounts based on their estimated total yearly purchases. Such orders may be assorted as to size and number, but must be for shipment to any single destination. (Strip and smoked charts excluded.)

Review the chart requirements of your entire organization and save by either above plan.

Bristol Recorder Ink Is Specially Compounded. Thirty years of laboratory development and field test have produced inks in 8 colors—non-fading even in atmospheres containing chlorine and sulphur dioxide fumes. Bristol Standard ink possesses the right surface tension for smooth flow and clean tracings, the right drying rate for average chart speeds, and is free of solids which plug pens. Bristol makes low temperature inks which will dry but not freeze at ambient temperatures down to —65°F and high temperature inks recommended for ambient temperatures up to 400°F. It is economical to buy Bristol's ink in pint, quart and gallon bottles to refill the handy 1 ounce dropper stoppered bottles supplied with each instrument.

Use Genuine Bristol Parts. Only Bristol replacement parts are identical with those originally built into your instrument. They assure ease of replacement and perfect performance.

● **THERMOCOUPLES** — Bristol tests thermoelectrically before shipment from our suppliers and after receipt at our factory every batch of thermocouple wire stock, accepting only those meeting precision checks against the National Bureau of Standards.

Buy Bristol's Thermocouples to obtain replacements which are exact duplicates of those for which your pyrometer was originally calibrated.

Service Chart Drives. Both main and branch factories carry stocks of carefully rebuilt, fully guaranteed chart drives, both spring and electric, which will be exchanged for your defective chart drive for a nominal charge. Note: in order to positively identify speed, gear ratios, mounting, etc., we *must receive your old chart drive before shipping the replacement.*

BRISTOL FIELD SERVICE

A coordinated, nation wide instrument engineering organization planned to serve users of industrial instruments whatever their problem — wherever they are located. Staffed by genuine experts in instrument application and maintenance.

Branch Factories. Three well equipped Branch Factories located across the nation in key industrial centers to speed up repair jobs and delivery of replacement parts and supplies. Each is manned by factory trained workers using factory methods, equipment and genuine Bristol parts in all phases of fabrication, calibration and repair. Instruments reconditioned in our factories carry the same guarantee as a new instrument. Parts and supplies likely to be needed in emergencies are stocked in all Branch Factories.

Sales Offices. Twelve Sales Offices located in strategic industrial cities thruout the United States and Canada, staffed by instrument engineers with years of "know how" in solving instrumentation problems of the industries peculiar to their districts. Call on these offices for personal engineering study, technical proposals and accurate quotations on your automatic process control problems.

Field Engineers. Over 50 experienced instrument engineers—experts in applying recorders and automatic controllers to industrial processes. These are the men who go into your plant, study your process and recommend equipment best suited to your job. They are available without cost or obligation to help you plan your instrument installations.

Service Engineers. Twelve field Service Engineers, all factory trained, to install, check, adjust and repair Bristol's instruments in the user's plant. Available at reasonable rates to go anywhere in the United States or Canada to maintain in your Bristol instruments, thru many years of usefulness, the same high accuracy and performance originally built into them. Bristol's Engineers make trips thru most parts of the United States, Canada, Cuba and England at frequent intervals. Avail yourself of this service by contacting the nearest Bristol Office.

Periodic Service [illegible] systematic plan designed to keep Bristol's instruments at top performance and accuracy. A Bristol Service Engineer calls periodically two to twelve times a year to inspect, check calibration, adjust, lubricate and repair all Bristol's instruments in the user's plant. We fix them *before* they fail! Use this plan to *prevent* costly lost production and product spoilage due to instrument break downs. Contact the nearest Bristol Office for full information on yearly contracts covering the Periodic Service Plan.

Technical Consulting Service. A complete consulting service based on over [illegible] years of experience in applying instruments to tens of thousands of widely varying processes and equipment. Just supply us with complete data—temperature and pressure ranges, flow rates, chemical characteristics, mechanical limitations, etc., and a sketch of the equipment. Our factory Application and Specialty Engineering Departments are available to advise automatic instrumentation for your tough and unusual processes.

BE SURE TO MENTION SERIAL AND MODEL NUMBERS WHEN ORDERING PARTS, INSTRUCTIONS AND DIAGRAMS

THE BRISTOL CO. WATERBURY 20, CONN.

BRISTOL'S

93511